Concrete

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The Joint Committee Report

A JOINT Committee with five representatives each from the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association has produced what is now pretty thoroughly before the engineering profession of the country—the report of the Joint Committee on Concrete and Reinforced Concrete, in the form of specifications for the use of these materials. The Joint Committee was organized in 1920 and since that time has held about one hundred sessions of from five to six hours each of the Committee as a whole and many sessions of the various sub-committees.

The report of the Joint Committee has been submitted to the several parent organizations and is being published and distributed by them. The question is often asked: What is the status of the Joint Committee report?

The status of the Joint Committee report is simply this: It *is*. It does not go for *adoption* to the various parent organizations, it is received and disseminated by them for whatever use it may be to the construction public.

The fact that the five parent organizations have no apparent right of ratification or of amendment to the Joint Committee report, prompted one humorist in the field to refer to the Joint Committee as a *Frankenstine*—a monster created by the five technical organizations which they are now unable to control. It is inconceivable that the five parent organizations should ratify the Joint Committee report. Richard L. Humphrey, chairman of the committee presented his viewpoint in regard to the report when it came officially before the American Concrete Institute at the last convention, following preliminary distribution to the membership of the Institute last summer. Mr. Humphrey points out that the report is offered with the idea that it will be used whenever it is found advantageous—that in the meantime the Committee has other phases of the subject of concrete and reinforced concrete on which it will probably make reports from time to time as the state of the art develops, and that it will make recommendations for changes in the report as now submitted. For this reason the Joint Committee invites discussion. The report has been given a good deal of discussion and there are notable examples of sharp disagreements with the findings of the Joint Committee, which is not, after all, surprising.

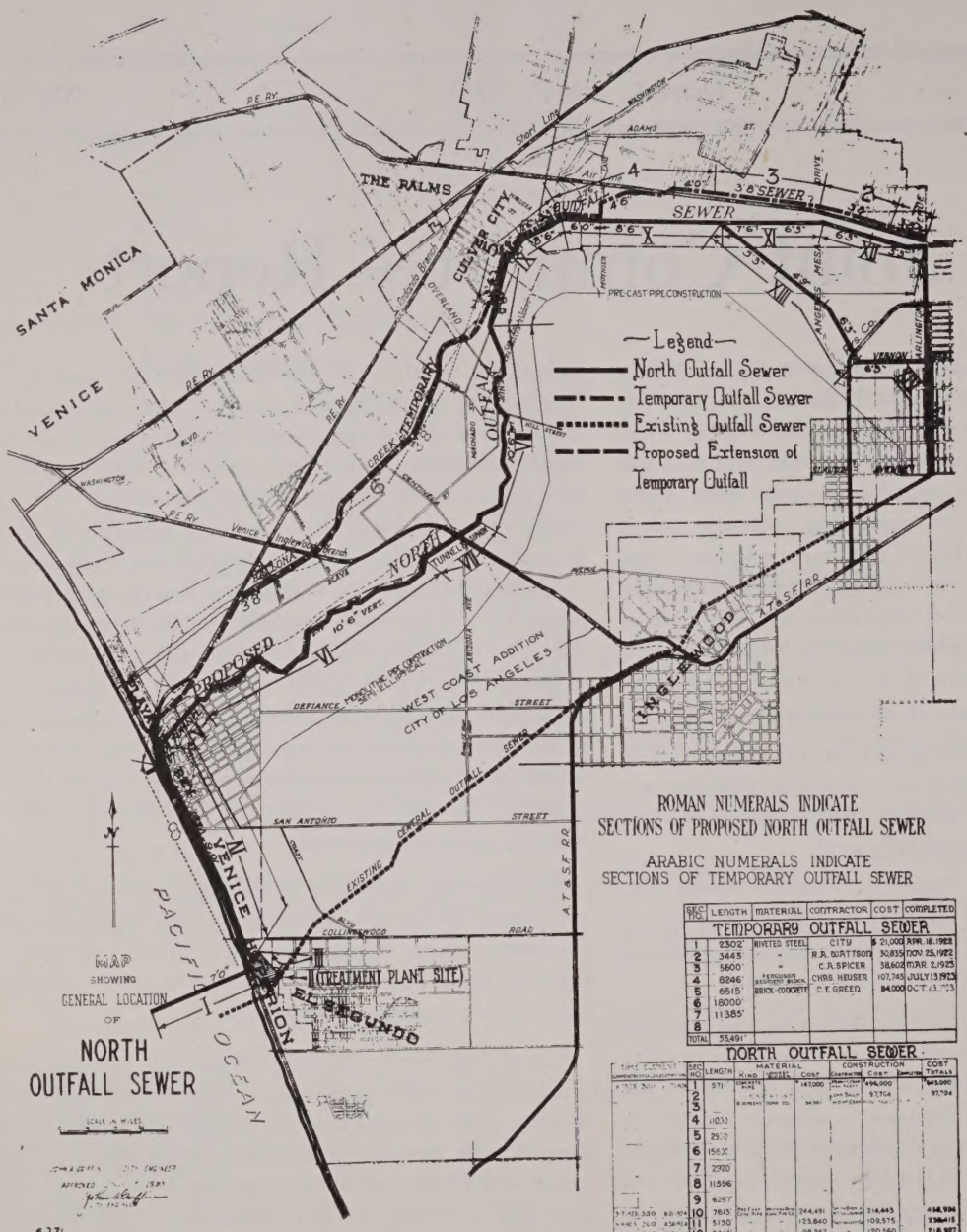
The value of the Joint Committee report will be demonstrated not merely in the extent to which it is used but also in the effect which the discussion of it has had and is now having, crystallizing engineering thought upon the problems which it involves and in directing practice in the construction field with concrete along new, progressive lines. The Committee does not undertake to conduct research—it tries to crystallize the results of current research into usable form and as is pointed out by Mr. Humphrey, it is no more than fair to say for the twenty-five members of the Joint Committee that there is probably not one of them in accord with all parts of the report. The report is a consensus of opinion and a consensus is usually at wide variance with individual opinion. It is submitted to the engineering public in the hope that it will be useful and may be a stimulant in developing the art of concrete—not with the thought that it is perfect or that it is in any sense the last word.

The very fact that many in the engineering profession do not agree with certain provisions and findings of the Joint Committee report is productive of a healthy study of the problems involved and probably will serve as the inception of new research and new design efforts.

Already we have seen very remarkable progress in the practice of control of quality of concrete on the job and in the ability of the contractor so to combine his materials as to predict with remarkable accuracy, when the concrete is mixed and placed, what its strength will be 30 days or 90 days hence. When the first progress report of the present Joint Committee was offered more than two years ago it raised a storm of objection to that section which admitted an alternative in which the contractor should be required to place concrete under specifications not of mixture but of ultimate strength and such organized thought was brought to bear upon the subject as a result of that widespread protest, that there has been remarkable advance in the knowledge of the construction fraternity in how to accomplish the very thing against the impossibility of which they so strongly objected.

Whatever flaws there may be in the Joint Committee report as a finished document, and whatever future use it may come to in the hands of the designing and constructing engineers of the country, it has already served a purpose in focusing thought upon some of the weak spots in connection with concrete construction.

Extensive Sewer Construction in Los Angeles



TEMPORARY OUTFALL SEWER

SEC TION	LENGTH	MATERIAL	CONTRACTOR	COST	COMPLETED
1	2302'	RIVETED STEEL	CITY	$ 21,000	APR. 18, 1922
2	3443'	"	R.R. GRATTSON	30,835	NOV. 25, 1922
3	5600'	"	C.A. SPICER	38,602	MAR. 2, 1925
4	8246'	FERGUSON RESISTIVITY BRICK	CHAS. HEUSER	107,745	JULY 13, 1923
5	6515'	BRICK-CONCRETE	C.E. GREEN	84,000	OCT. 13, '23
6	18000'				
7	11385'				
8					
TOTAL	55,491'				

NORTH OUTFALL SEWER

SEC NO.	LENGTH	MATERIAL KIND	MATERIAL COST	CONSTRUCTION CONTRACTOR	CONSTRUCTION COST	COST TOTALS
1	5711	CONCRETE PIPE	141,000		$98,000	$239,000
2					97,704	97,704
3						
4	1030					
5	250					
6	1562					
7	2920					
8	11596					
9	6267					
10	7613		244,491		214,443	458,934
11	5130	"	123,840		109,575	233,415
12	5414	"	98,367	"	120,560	218,927
13	9802	"	163,567	"	172,605	336,172
14	8314	"	192,069	"	249,000	441,069
TOTAL	82947					

Fig. 1—Map showing the location of the North Outfall Sewer, Los Angeles, California, and the various sections into which it was divided for contracts

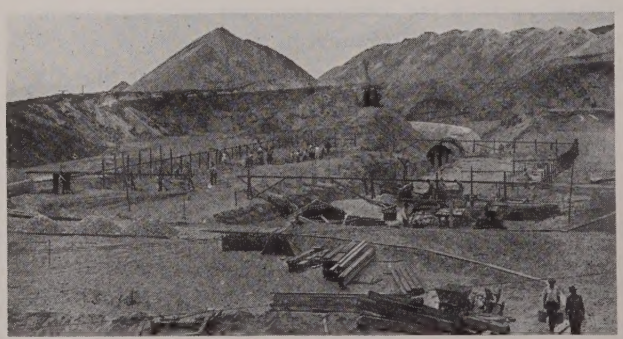


Fig. 2—Site of the proposed screening plant for the Los Angeles Outfall Sewer showing part of the completed tunnel section

Los Angeles North Outfall Sewer Includes Various Types of Concrete Construction

In the design and construction of the North outfall sewer of Los Angeles, the original 14 sections of which are now in operation, many interesting problems arose and the types of construction finally adopted include precast reinforced concrete pipe, plain monolithic concrete, precast concrete pipe with vitrified clay lining, and concrete in tunnel placed by the use of a concrete gun. The 14 sections total 17 miles in length and cost approximately $7,000,000. The entire system can care for the sewage of a city of 3,000,000 people.

In order to ascertain as to the advisability of substituting 7-ft. precast reinforced concrete pipe in place of cast iron of the same diameter for the mile of ocean outlet of the permanent outfall sewer, an investigation was made by the Los Angeles Board of Public Works as to the effect of sea water and sewage on reinforced concrete pipe construction for sewers. At Oakland, Calif, it is found that 1200 ft. of 36-in. reinforced concrete pipe for sewage purposes laid in 1907, which is entirely submerged at high tide, and another sewer 5½ ft. in diameter of reinforced concrete pipe laid in such a manner as to be two-thirds submerged in salt water, were found in as good condition as when constructed over 15 years ago.

In 48th Ave., San Francisco, a 7-ft. x 9-ft. tunnel was built and lined with concrete where it was subject to the action of sea water, and this was found in as good condition as when laid. The Howard St. sewer, laid in 1912 and varying from 6 ft. to 7 ft. in diameter of reinforced concrete with a 1:2:4 mix, was found in as good condition as when laid although it had at times been subject to ebb and flow tide and to sewage gases.

The Board of Public Works recommended that from the standpoint of economy and where durability or efficiency would not be sacrificed that the mile-long ocean outlet at Hyperion should be constructed of precast reinforced concrete pipe, the walls of the pipe to be not less than 9-in thick, the action resulting in an estimated saving of $250,000 as compared with cast iron pipe for the same purpose.

Six sections of the system include the use of precast reinforced concrete pipe, furnished by contractors, and the other sections are of plain concrete, monolithic, semi-elliptical type. The sewer extends from the southwest section of Los Angeles toward the ocean at Playa Del Rey and then proceeds along the beach to Hyperion where it extends one mile out into the Pacific Ocean.

On February 9, 1923, the first construction contract on the outfall sewer was awarded, calling for the removal and disposal of approximately 700,000 cu. yds. of material at Hyperion, the site of the screening plant. The work was done by the hydraulic method and the material washed into the sea. The total contract price for this excavation work was $97,000 or 14c per cu. yd.

On July 30, 1923, bids were called for the construction of Section No. 1, consisting of pre-cast reinforced concrete pipe, cast in 12-ft. lengths and 7 feet in diameter. The bid accepted for the pipe was for $147,000 and for the construction of the ocean outfall, on the basis of concrete pipe construction, $496,000. A study was made of various types of sewage screen for Sections 2 and 3, and the fine drum type was decided upon. The Dorr Co. was awarded the contract to furnish the equipment for the south plant, which consisted of 8 drum type screens with bucket elevators at a cost of $54,961. The sewer was then extended 2000 ft. into the ocean in order to provide an outlet for the overloaded sewer mains, and the screening plant was used to remove solids. Section 2, the plant site, was constructed at a cost of approximately $152,000, and Section 3, the screening plant, at a cost of $484,000.

The ocean outfall, known as Section 1, comprised two contracts; one for making the pipe and the other for installation. The pipe, which was slip joint type, was manufactured by John Balch on the ground at Hyperion, using the following aggregates: 1 part portland cement; 1½ parts sand, and 2½ parts crushed rock or gravel. Each joint of the outlet weighs 36,000 lbs., and four joints were laid at each operation. The installation of the pipe joints was handled by the Merritt-Champany & Scott Corp. by unique methods.

The pipe was laid in a trench on the ocean floor with that portion through the surf being supported by pile bents. Alongside of that portion of work where piling was specified, a pier was built and used for the construction of a sheet pile cofferdam. Within the cofferdam, the trench was dredged and the pile foundation driven. The caps were then placed and the pipe, which were transported from Hyperion siding by flat cars, were lowered into place one at a time and the joint sealed by divers using a bitumastic compound. Beyond the cofferdam, where the water is deeper, a different method was used. On the launching end of the pier a platform was constructed where four lengths of pipe were assembled into one section. These sections were then fastened to air-controlled pontoons and skidded down into the water, floated into the proper location and lowered into place. This method reduced underwater work to a minimum, as only one out of every four joints was made by divers.

The entire ocean outlet, or Section 1, consists of reinforced concrete pipe, 7 ft. in diameter, laid in a trench on the floor of the ocean to a point approximately 5000 ft. from shore, at which point two 5-ft. pipes are laid in such a way as to form a 90° angle with each other and a 45° angle with the main line. These pipes discharge through standard base elbows approximately 56 ft. below mean sea level.

For Sections 11 to 14, inclusive, precast reinforced concrete pipe with vitrified clay lining, was decided upon, ranging in size from 4 ft. 9 in. to 8 ft. 6 in. Approximately 36,700 lin. ft. of pipe was furnished by the Western Concrete Pipe Co. for $822,312, at the following listed unit prices:

Size of Pipe	Price Per Foot
4 ft. 9 in. I. D.	$12.60
5 ft. 3 in. I. D.	15.60
6 ft. 0 in. I. D.	19.95
6 ft. 3 in. I. D.	21.55
7 ft. 6 in. I. D.	28.90
8 ft. 6 in. I. D.	35.25

Contracts for the construction of Sections 11, 12, 13 and 14 were awarded to the Thomas Haverty Co. at the following prices:

Section	Size		Length	Bid Price
11	6 ft. 3 in.		3322 ft.	$ 66,365
	7 ft. 6 in.		1808 ft.	43,210
		Total	5130 ft.	$109,575
12	5 ft. 3 in.		2995 ft.	$ 70,155
	6 ft. 3 in.		2384 ft.	46,940
		Spec. Structure	35.39 ft.	
			5414.39 ft.	$120,560
13	4 ft. 9 in.		3190 ft.	$ 50,025
	5 ft. 3 in.		3209 ft.	59,810
	6 ft. 3 in.		3402 ft.	62,770
		Total	9801 ft.	$172,605
14	6 ft. 3 in.		8906 ft.	$247,600
		Spec. Structure	8.25 ft.	1,400
			8914.25 ft.	$249,000

Sections 11 and 12 are part of the main line of the sewer, Section 12 connecting with the old outfall sewer at Arlington street and running west in Rodeo Road to Mesa Drive, a distance of 5130 ft. Sections 13 and 14 are a branch of the main outfall line, Section 13 connecting with the main line at the west end of Section 11 and running southeasterly along Baldwin Hills to a point near Mesa Drive and Vernon Ave., a distance of 9802 ft.

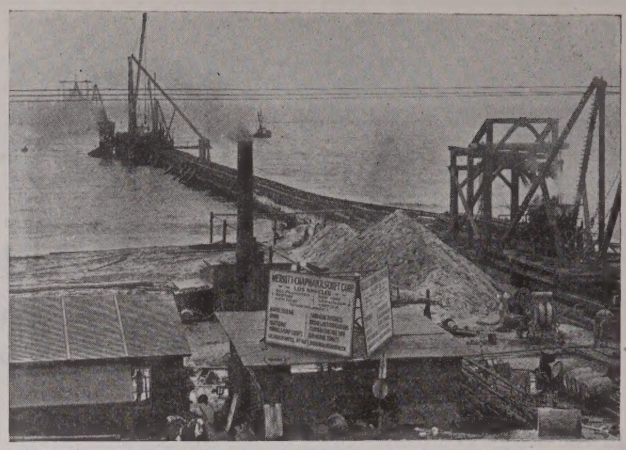
Section 14 extends east from Mesa Drive in Vernon ave. to Van Ness Ave. and thence south in Van Ness Ave., paralleling the outfall sewer to Slauson Ave., a distance of 8,914 ft.

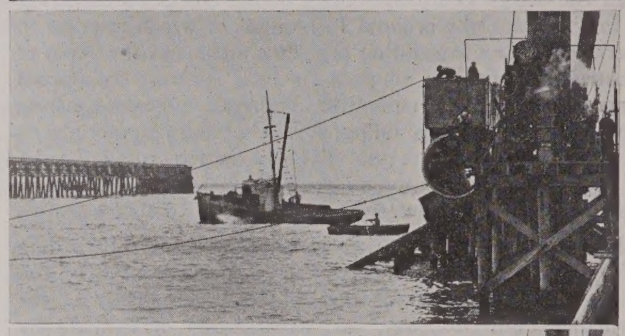
Concrete Pipe with Vitrified Liners

The method of constructing the pipe with vitrified tile liners is one of the most interesting features in the construction of Sections 11 to 14. The tile liners are curved slabs 9⅓ in. wide, 18 in. long and 1 in. thick. The dove-tailed projection at each side of the tile running longitudinally with the length of the tile served to make a bond with the concrete. As the heavy corrugations provide an excellent bond with the concrete, even when the tile is unsupported, it cannot be dislodged from the concrete without breaking both the concrete and tile. The tile is almost a counterpart of the inner piece of the Ferguson segment block which is a patent clay block. These liners are made with two different radii, 27-in. and 45-in. The 27-in. radius was used for tile liners for all pipe having interior diameters ranging from 54 to 90 in. and the 45-in. radius was used for pipe greater than 90 in. in diameter.

In constructing the pipe with the clay liners a steel core or inside form was first set up on the bottom ring, and the liners set in place around the core. No. 12-gauge black annealed wire was used to tie and secure each layer of tile against the core. With the case or outer form in place, the concrete was poured in the same manner as if the tile liners were not used. In cases where the tile lining overran in length and extended beyond the ends of the pipe when made, it was found practicable to chip off the ends of the tile with a hammer after the concrete was completely set.

In designing the reinforcement for this pipe, due allowance was made for an increase of reinforcement due to decreased thickness of concrete made necessary by the use of the tile lining. No allowance was made for the strength of tile lining whatever. It was the opinion of the manufacturers after observing some practical tests of this pipe that a very considerable strength could be allowed for tile linings used in this manner. It was found that when a pipe fractured under load, or when being tipped to a horizontal position, the first breaks in the concrete appeared on the inside, both top and bottom and in practically 90% of the cases, the cracks did not appear at the spring line on the outside of the pipe. It is pointed out by the manufacturers that this is due to the fact that the moment at the spring line of a pipe under load is only about 6/10 of the moment at the top and bottom of the pipe.





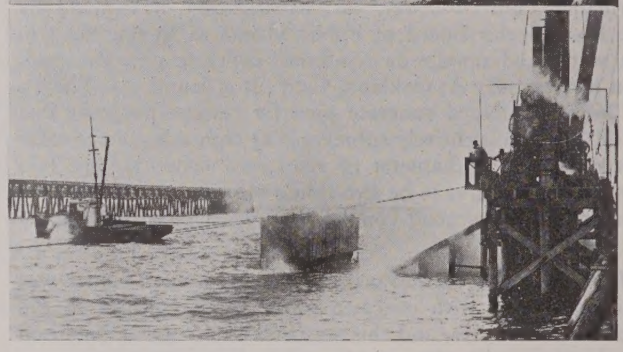


Fig. 3—General view of early construction of ocean section with section of pipe resting on the slide at end of pier

Fig. 4—Section of pipe with pontoon ready to be pulled into the water

Fig. 5—Pipe slid into the water and kept floating by the pontoon

In tipping some of the large pipe without internal bracing, a few showed fracture of the concrete. These fractures appeared on the outside of the spring line and no fractures on the inside. If any fractures had appeared on the inside, these could have been readily observed by inspection of the collars and bells. It was concluded therefore by the manufacturers that the dove-tailed projections of the tile linings engaged the concrete so securely as to prevent fracture of the concrete under tensional stress and permitted the steel to do more of the work.

It is not necessarily a fact that tile lining in itself has greater strength in tension than the concrete has, but it was apparent to the manufacturers that the peculiar virtue of reinforced concrete is the manner in which the steel reinforcement distributes the infinitesimal cracks in the concrete and for all practical purposes increases the elasticity of the concrete. Reinforced concrete when strained to the failure of the concrete has been strained beyond the elastic limit which has been increased by the use of the steel reinforcement. The tile lining, however, has little or no elasticity and so long as the full strength of the reinforced concrete and tile lining is not reached, no failure will result. These deductions were drawn by the manufacturers of the tile-lined pipe in explanation of the action of this type of construction under load.

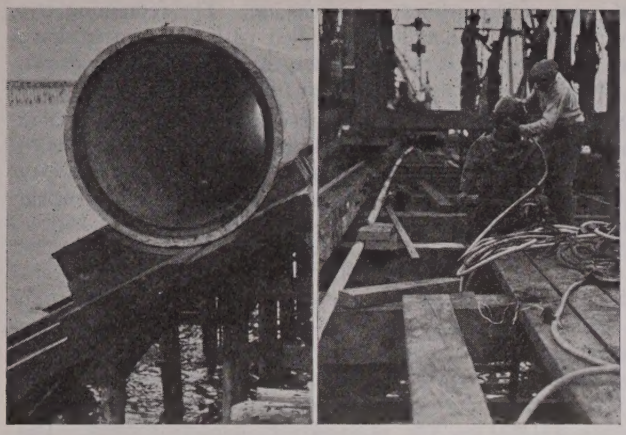


Fig. 6—Close-up view of section of pipe composed of 4 lengths joined together before placing under water

Fig. 7—Diver preparing to go under water to join lengths

The use of tile lining in reinforced concrete pipe was decided upon by the city officials of Los Angeles, for the reason that Los Angeles sewage casts off sulfuric acid gas in unusual quantities due to the length of the outfall and is therefore believed to have a deleterious effect on concrete. This gas, however, would have to destroy the concrete over 50% of the area of the back of the tile lining before the bond between the tile lining and concrete would be seriously affected. For shorter lines and under ordinary conditions of sewage, the tile was considered entirely unnecessary.

Nearly one-half of Section 7 was of tunnel construction, while the remaining half required the use of an inverted siphon to cross a low field. The tunnel was 1470 ft. long and was driven in 70 days. The lining was placed by the use of the Universal concrete gun in 45 days and the work was done by force account.

The Universal concrete gun, which is a local invention, is cylindrical in shape and is made in two sizes: 24 in. and 30 in.

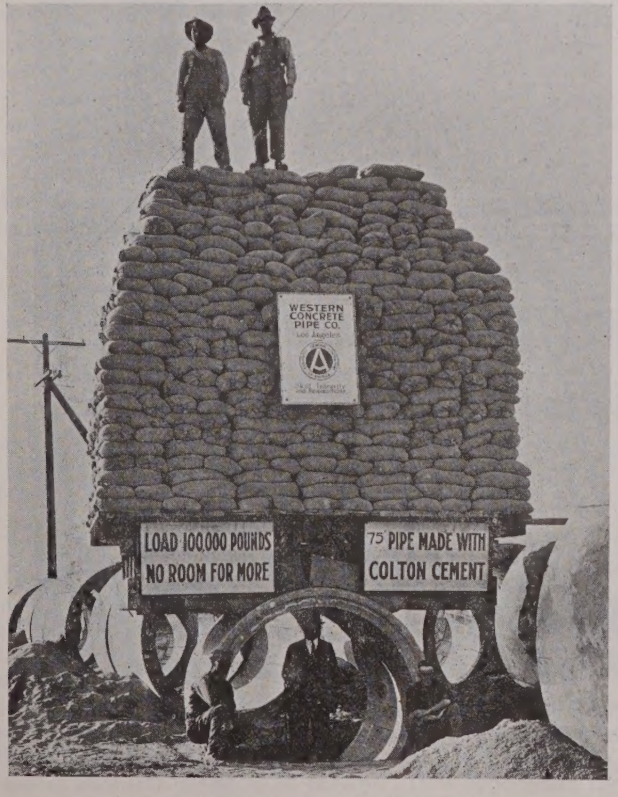
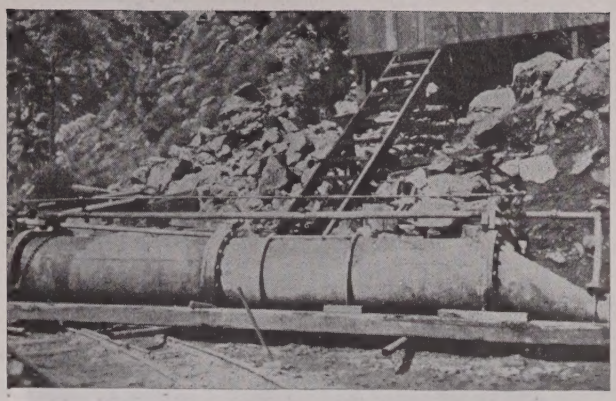
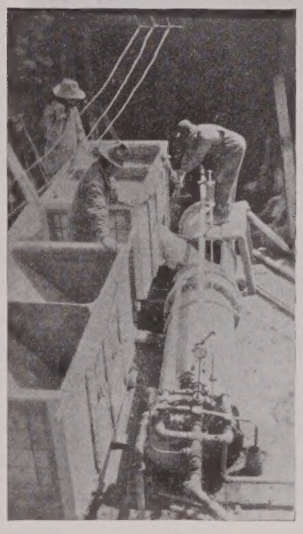


Fig. 8—Test of 75-in. concrete pipe made by the Western Concrete Pipe Co.





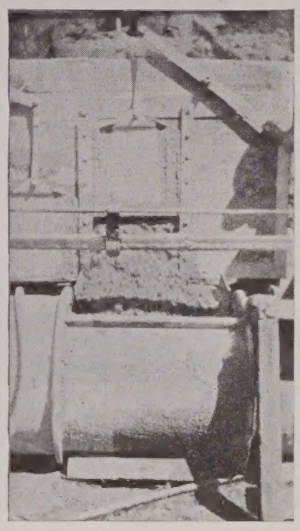


Fig. 9 (top)—Universal concrete gun used for placing tunnel lining in tunnel section of sewer

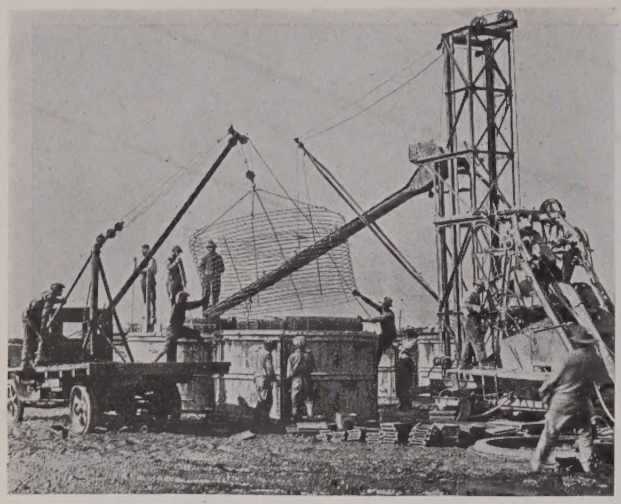
Fig. 10 (lower left)—Car discharging concrete into charging chamber of concrete gun

Fig. 11 (lower right)—Close-up view showing concrete discharging by gravity from car into charging chamber of concrete gun

inside diameter. The 24-in. gun will handle 11 cu. ft. of concrete at a charge and the 30-in. gun will handle 20 cu. ft.

The machine is divided into two cylindrical compartments by a partition plate equipped with a stuffing box; a piston with a head on each end operates through this box. The cylinder is connected to the concrete delivery line by an eccentric tapered reducer. One section of the cylinder is the

Fig. 12—Laying reinforced concrete pipe in open cut with the aid of special machinery designed by the contractors, the Thomas Haverty Co.



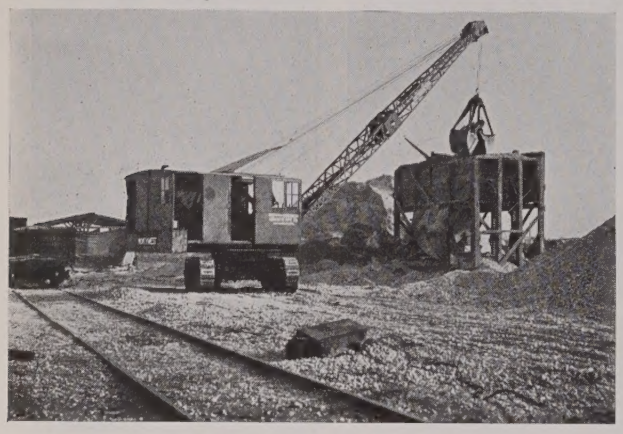


Fig. 13—Inserting assembled reinforcing steel after the form sections have been painted with neutral oil and placed on the steel ring on the ground. The form sections and reinforcing steel are handled by the small crane operating on the motor truck. On the right is a specially designed concrete mixer especially constructed for this job

Fig. 14—Proportioning aggregates for concrete pipe with the aid of crane and overhead bins

air chamber for the operation of the piston, and the other section is for receiving and discharging the concrete. All operations of the gun are air controlled and the valves are located so that one man can control the entire machine.

The gun is mounted on trucks which travel on tracks laid alongside and parallel with the industrial track. The gun track is built in sections and of light rail. Sections are passed around the gun when it is to be moved which occurs once each shift of eight hours. Cars, suitably mounted and equipped with convenient doors, are spotted alongside of the gun and the concrete from the cars is discharged into the gun by gravity. When the concrete is loaded into the gun it has already been mixed to a proper consistency. The piston, which operates through the stuffing box, keeps a continual supply of concrete under the air jet and thereby gets the full effect of the air consumed in forcing the concrete through the delivery pipe. The capacity of the gun is estimated to be approximately 200 cu. yds. per day of eight hours.

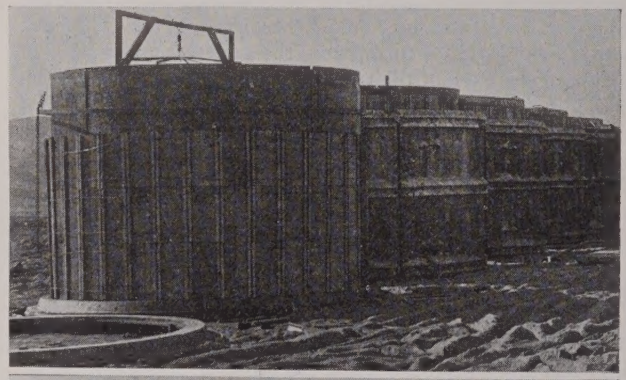
The siphon portion of Section 7, due to varying flow, presented a difficult problem, but a plan was evolved calling for the construction of three 78-in. lines of precast reinforced concrete pipe laid on a concrete slab, and each line tested to withstand a pressure of at least 26 lbs. per sq. in. The contractor guaranteed the pipe to withstand the required pressure, and the city agreed to furnish the materials and construct the junctions at either end. Charles Thompson was awarded the contract for the construction of these three lines at the sum of $93,000, and the work approximated 1769.67 lin. ft. Only one of these lines is now in use. The remaining two lines, completely installed and filled with pure water, have been sealed to await the day when the city shall have grown to a population necessitating their use.

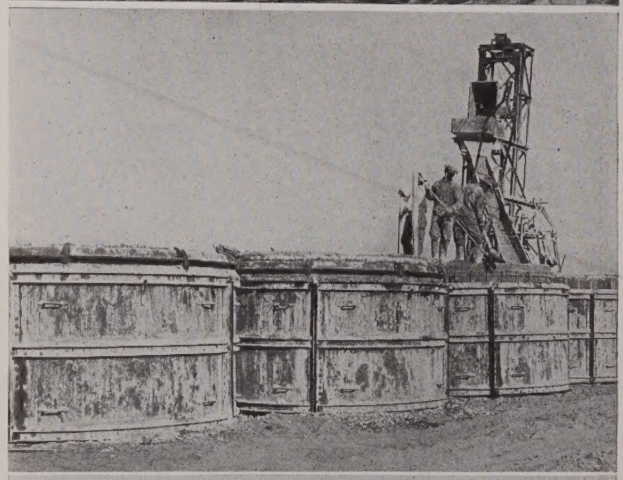
Sections 4, 6, and 8 called for construction, complete in place, of monolithic and semi-elliptical concrete sewer, with vitrified clay lining, having a height of 10 ft. 6 in., the city to furnish free of cost to the contractor along the line of work, all sand, rock, cement and clay reliners required.

Section No. 6

Section No. 6, including the excavation and construction of the sewer complete was done by Callahan & Cooney at a contract price of $298,000. This section winds its way around the foot of the Baldwin Hills for approximately 3 miles and in the construction work it was necessary to excavate approximately 300,000 cu. yds. of sand very densely packed. The excavated material was overcast to the valley side and formed a road for shovels, mixers and other equipment.

The sewer was made of reinforced concrete, poured over Blaw-Knox forms, semi-elliptical in cross sections. The diameter was 10 ft. 6 in. A lining of vitrified clay blocks was provided by first laying the blocks directly over the forms. They were held in place with metal clips specially designed





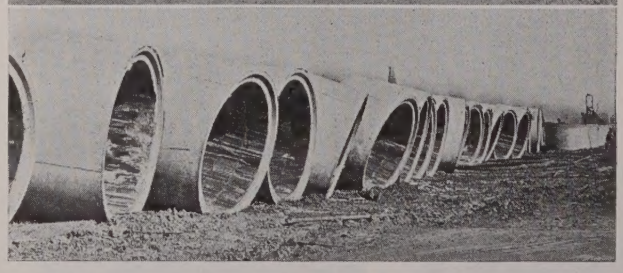


Fig. 15—Pipe molds being set up on the steel ring bases and tile liners placed ready for pouring

Fig. 16—Forms complete and concrete being poured

Fig. 17—Row of finished pipe showing the appearance of the interior face with the tile lining

and the concrete was poured between the metal forms and the outside wooden forms.

Rough mixing was done at a central concrete storage plant located near the middle of the job. Trucks were used to deliver the cement, sand and stone, the aggregates being dumped directly into hoppers from which they were carried by conveyors to the storage bins. These storage bins were so elevated that the material could be discharged directly into batch boxes on a train of Koppel cars, each batch box being filled automatically with the correct proportion of material from the hoppers beneath the bins.

Two 7-ton Plymouth locomotives were used to haul the roughly mixed dry batch over a narrow gauge railroad for a maximum distance of about 1½ miles to the concrete mixer, a 21-E Smith paver. The batch boxes were lifted from the cars and deposited into the mixer with the aid of a small crane attached to the side of the mixer. Concrete was handled from the mixer to the forms in specially constructed buckets handled by a gasoline crane. The concrete was mixed 1:3:5 cement, sand, and crushed rock or screened gravel. All concrete aggregate and vitrified clay sewer lining blocks were furnished by the city of Los Angeles. Other equipment used included a small Fairbanks-Morse gas engine, equipped for pumping water to the job.

Section 9, the transition section between the precast sections and the large semi-elliptical sections, called for a short length of 10 ft. 6 in. size and the balance 7 ft. 9 in. of the same type, with all material furnished. Contracts were awarded as follows:

Contractor	Section	Length	Size	Price
Ross Construction Co.	4	11,050 ft.	10 ft. 6 in.	$303,300
Callahan-Cooney Const. Co.	6	15,197.95 ft.	10 ft. 6 in.	298,000
Atkinson-Spicer Co.	8	10,906.22 ft.	10 ft. 6 in.	249,500
Thos. Kelly & Sons	9	79.18 ft.	10 ft. 6 in.	
		6,215.14 ft.	5 ft. 9 in.	165,516

While construction work was being rushed on the North outfall project, special work was completed on the temporary outfall sewer, and was included in the $7,000,000 program. The Pacific Tank & Supply Co., and the Redwood Manufacturing Co. installed 20,000 ft. of woodstave pipe, and The Bent Concrete Pipe Co. installed 9000 ft. of standard reinforced concrete pipe as follows: 6000 ft. of 54-in. and 3000 ft. of 42-in. with .6% transverse circular reinforcement which comprised two rings each .3%. The mix was 1 part portland cement, 2 parts sand, and 3½ parts rock.

The entire time required for building and completion of the temporary outfall sewer occupied approximately 100 days, and the entire cost was $670,943.66.

The North outfall sewer project was carried out under the direction of the Los Angeles Board of Public Works, the design being approved by John A. Griffin, city engineer.

Super-Cement Possibility of Future

The following is an interesting excerpt from a paper presented at the recent meeting in New York of the American Institute of Mining and Metallurgical Engineers by John J. Porter, first vice president and general manager of the Security Cement and Lime Co., Hagerstown, Md.

"An interesting problem is the possibility of producing a super-cement, one having a materially greater strength than is now the practice, by carrying the lime in the mixture a little higher than at present, burning correspondingly harder and grinding much finer. Much work has been done along this line, especially in Germany but there is much work to be done. Within the past year a research organization, supported jointly by the Portland Cement Association and the Bureau of Standards has been established to study the fundamental chemical problems of cement. It is hoped that the result will be a better understanding of many things that are now puzzling the practical operating men of the industry."

Unusual Problem in Concrete Road Materials

Discussion by Duff A. Abrams

PROFESSOR IN CHARGE STRUCTURAL MATERIALS RESEARCH LABORATORY, LEWIS INSTITUTE, CHICAGO

The following discussion is offered on C. M. Conner's article on Concrete Roads in CONCRETE for January, 1925, p. 10.

Mr. Conner states:

On a certain project all of the materials including cement, sand and stone had passed the specified requirements for physical tests. Concrete pavement had been in course of construction for some time when an inspector discovered a very unusual condition in the appearance of the water in the ponds used for curing as well as of the pavement surface itself under the ponds.

The ponding water was covered with a scum which floated on the surface while below the surface a greyish yellow material was held in suspension. The pavement surface itself showed a scale and was so soft it could easily be scratched with a sharp pointed instrument after having set for more than 16 days in warm weather.....

It is a matter of common knowledge that water in contact with portland cement becomes alkaline by dissolving calcium hydroxide from the cement. Where the amount of water is small as compared to the area of fresh concrete exposed (as in "ponded" roads) this solution may become sufficiently concentrated to give to the water a soapy feel. This dissolved calcium hydroxide reacts with the carbon dioxide always present in the air to form the nearly insoluble calcium carbonate.

It is entirely characteristicof this reaction that the calcium carbonate should form a scum on the water. The motion of the water coagulates the extremely fine particles of this scum sufficiently to cause them to settle, whereupon more scum is formed. Due to their small size the particles settle slowly. Agitation of the water by air currents would tend to keep the particles in suspension. The deposit of the calcium carbonate on the concrete may become mixed with clay or other impurities in the water. Ordinarily the color would be whitish grey, which might be modified by clay to the greyish-yellow mentioned by Mr. Conner.

We do not believe that either free or combined carbon dioxide in the ponding water or aggregate need be considered. Almost all waters contain small amounts of carbon dioxide, dissolved or combined as carbonates or bicarbonates. It is very difficult to conceive how any aggregate could contain more than a trace of free carbon dioxide. Most natural aggregates contain combined carbon dioxide. The calcareous gravel from Elgin, Ill., which we use in many of our concrete tests (a high-grade aggregate) contains over 20% carbon dioxide or over 200,000 parts per million; a limestone may contain over 50% carbon dioxide or 500,000 parts per million.

Since a more logical and simple explanation of the condition observed by Mr. Conner is possible, it seems unnecessary to attribute it to aggregate or water, especially since all the probabilities point to another explanation.

Mr. Conner states that this condition is unusual; it may be this road was ponded earlier than usual, which would permit a more active solution of calcium hydroxide.

While the causes of scaling are in many instances very obscure, we have no reason to believe that "ponding" in the approved manner contributes to this phenomenon. It is quite certain that the formation of the scum described by Mr. Conner was in no way responsible for scaling.

Handling Materials for Substructure of $25,000,000 Power House

By Frank W. Skinner

More than 200,000 cu. yds. of concrete is being used in the $25,000,000 14th St., New York power house with full size concrete foundation slabs 15 ft. thick. Highly developed mechanical plant for handling and storing cement and aggregate and mixing and distributing 1,000 yds. of concrete per day, are features of unusual interest. The new power house now under construction at the foot of East 14th Street, New York City by the Kenn-Well Co. for the New York Edison Co. will include a 206 x 274-ft. and a 206 x 210-ft. building about 130 ft. high with wooden pile foundations covered with a continuous layer of concrete 15 ft. thick placed in 7- and 8-ft. lifts. The slabs will be divided by vertical construction joints into sections of from 800 to 1,000 cu. yds. and united, at the sides, by horizontal tongue and groove joints up to 30 in. wide. The building was designed by Thomas Murray, Inc., construction engineers, in accordance with the specifications of E. M. VanNorden, engineer for the New York Edison Co.

The soil at the site consisted of fill, earth, sand, old foundations, timbers and boulders, of which about 110,000 cu. yds. were excavated to a general depth of about 16 ft. by the Thomas Cummins Contracting Co., F. N. Benedict, chief engineer, who installed two ¾-yd. steam shovels. About 30,000 yds. of tunnel excavation in deeper trenches was handled by clamshell buckets.

The ground was so wet that thorough drainage was necessary to permit the operation of the steam shovels, and water was collected in a system of trenches that eventually delivered into a single special sump, bottomed and enclosed by a sort of blind drain of broken stone and equipped with two 8-in. Kingsford centrifugal pumps,[1] each driven by a 20-h. p. electric motor. One pump was generally held in reserve, and the other sufficed to drain the soil so thoroughly that it became much denser and had sufficient stability to support loaded motor trucks close to the edge of a vertical bank.

Before completion of the sump and at other times during the progress of the work, shallow ditches delivered to various other sumps that were effectively drained by two gasoline-driven portable pumps. A considerable amount of foundation stone and boulders were encountered, that required breaking before removal. These were very efficiently block drilled by air furnished by the Chicago Pneumatic Tool Company's portable gasoline-driven compressor[2] with a capacity of 150 cu. ft. of free air per minute that operated two jackhammers and was easily shifted from place to place so as to supply the air through a short length of hose.

The steam shovels worked in two lifts, delivering directly to a fleet of 5-ton Mack motor trucks[3] running over planked roadways in the excavation and operated so effectively that little time was lost in waiting for them to receive the dipper loads. Three 1-yd. Hayward clamshell buckets[4] were advantageously operated between the braces of the tunnel sheeting by tackles suspended from the booms of derricks or handled by steel brooms that eventually replaced the dipper booms of the steam shovels.

The foundation, under the massive concrete footing slabs, consists of about 18,000 untreated yellow pine piles driven for the Thomas Cummins Co. by the P. T. Cox Contracting Co. The piles are 12 to 14 in. in diameter and are driven to penetrations of 15 to 30 ft. by 7 steam hammers operated by derrick booms on 2 travelers and by 2 ordinary land drivers that were more easily shifted to different groups or for piles inaccessible to the large travelers. The piles were designed for loads of 20 tons each, which were fully justified by the results of the test pile driven in advance of the main body of piles.

There were installed, four of them on two two-boom special travelers, 5 McKiernan-Terry 9-B steam hammers[5] striking 140 blows per minute with an energy of 7727 foot pounds each.

Fig. 1—Slat conveyor, unloading cement scow and dumping automatically to conveyor supplying storage house and charging platform for concrete mixer

Fig. 2—Swivel chute delivering premixed aggregate from bucket elevator to belt conveyor distributing to compartments of receiver bin

[1]Kingsford Foundry & Machine Works, Oswego, N. Y.
[2]Chicago Pneumatic Tool Co., 6 East 44 St., New York City.
[3]International Motor Co., New York City.
[4]The Hayward Co., 50 Church St., New York City.
[5]McKierman-Terry Drill Co., 17 Park Row, New York City.

The best record of one steam hammer was 77 piles driven in one 8-hour shift.

In order to allow for variation of steam pressure in the double-acting hammer, a chart was calculated from a modification of the *Engineering News* hammer formula that showed the safe load when the piles were driven with various pressures in the steam cylinder.

The two land machines, each equipped with a No. 2 Warrington-Vulcan steam hammer,[6] drove a maximum of about 67 piles in one shift. These hammers have a 3,000-lb. ram with 36-in. stroke. The piles driven by them were checked up by special tables showing the safe load when the penetration for the last ten blows was from 3 to 6 in. All of the pile driver machines and two wooden stiff-leg derricks were equipped with Lidgerwood hoisting engines,[7] of which there were installed on the job 12 double and triple drum machines, some of them also provided with swinging engines which were used for nearly all hoisting purposes on this job.

The dredging of the river front about 370 ft. long, the construction of the concrete bulkhead wall on a pile foundation and the building of 26 x 172-ft. screen well under another contract, by the Phoenix Construction Co., involved a large amount of cofferdam work for which there were required about 3000 tons of 14-in., 35-lb. arch-web Lackawana steel sheet piles[8] from 50 to 65 ft. long that were driven in single lines and in double lines connected by cross wall ties, forming cells or pockets. The connections between the main and cross walls were made with fabricated T-joints designed to resist heavy tension.

The contractor erected two large wooden buildings,—one for his offices and for the emergency hospital and another for general storage, supplies, spare parts, etc. He provided a smith shop, pipe shop and a carpenter shop, all equipped with suitable machine tools driven by separate electric motors and including a special saw table with two arbors, permitting the change from rip to cross-cut without the loss of time. A telephone system was also provided with a switchboard and eight extensions to all the principal points of the work.

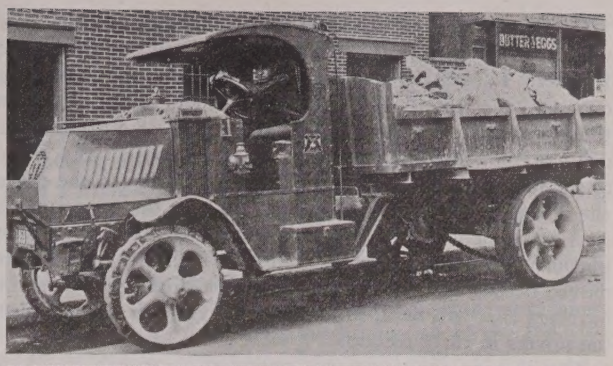
Because of the large area of construction operations, about two city blocks, the enormous quantity of materials handled and the necessity of providing for carrying on different operations simultaneously without delays or obstructions, a very careful study was made of 9 alternative plans for different arrangements and installations of equipment for handling, storing and conveying cement, aggregate and concrete. All of them included a suspended spouting system supplemented by counterweighted pivoted trusses for the concrete, but various systems and different equipment were considered for the aggregate and cement unloading, storage and delivery to concrete mixers.

Various arrangements of fixed and movable derricks, open pile and bin storage, conveyors etc. were compared. Their best features, greatest security against interruption of service, and highest efficiency were combined in the plan that was finally adopted.

It provides for unloading and storing cement at the west end of the slip, and for unloading stone, sand and reinforcement steel on the north side of the slip by means of four 50-ft. working radius booms on 2 steel gantries that travel over the sand and stone storage bins on a track of 44-ft. gauge, 260 ft. long on the north side of the slip. Sand and stone are delivered from this storage bin to the mixer by a short distributing conveyor over the mixer bin.

All fixed derricks are eliminated for the storage and mixing operations, the sand and stone storage at the mixers are great enough to provide for a considerable interruption of delivery without stopping the concreting, and the cement shed is so near the mixers that if necessary, cement could be delivered without the use of the conveyor belt for a short period. The aerial distributing systems fully command the entire area of

[6]Vulcan Iron Works, Chicago, Ill.
[7]Lidgerwood Mfg. Co., 96 Liberty St., New York City.
[8]Lackawanna Steel Co., Buffalo, N. Y.



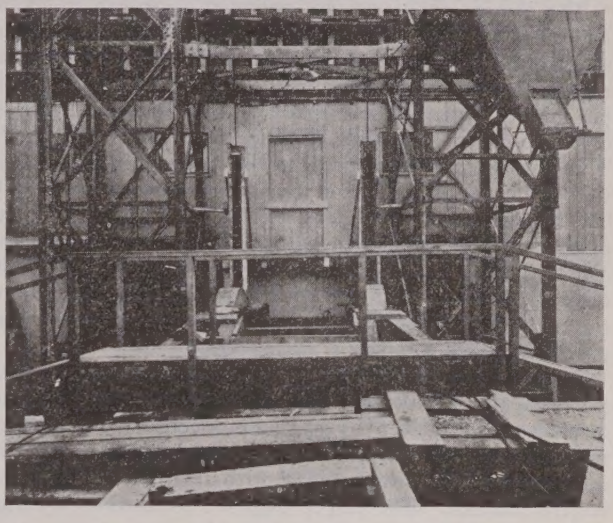


Fig. 3—Five-ton truck loaded with stone handled by steam shovels
Fig. 4—Lower part of 240-ft. twin hoisting tower. Buckets independently hoisted and lowered are filled through automatically revolving chutes

the work at present under construction by means of the two subterminal derrick masts located about 290 ft. and 304 ft. from the hoisting tower.

There will be used for this building about 200,000 cu. yds. of the highest grade of concrete aggregate supplied by the Kittaning Sales Co., New York. It is two parts sand and four parts gravel, dredged on the north shore of Long Island. It is delivered at the site in ready-mixed scow-load lots and is very clean and well graded, making a dense, uniform mixture, guaranteed free from loam. The gravel does not exceed 1½ in. in diameter. Atlas portland cement, about 900,000 bags in all, supplied by the Atlas Portland Cement Co., is mixed with it in the proportion of one part by volume of cement to six parts of aggregate. The concrete will be reinforced by more than 2,000 tons of Donner deformed steel bars.[9]

[9]Donner Steel Co., Buffalo, N. Y.

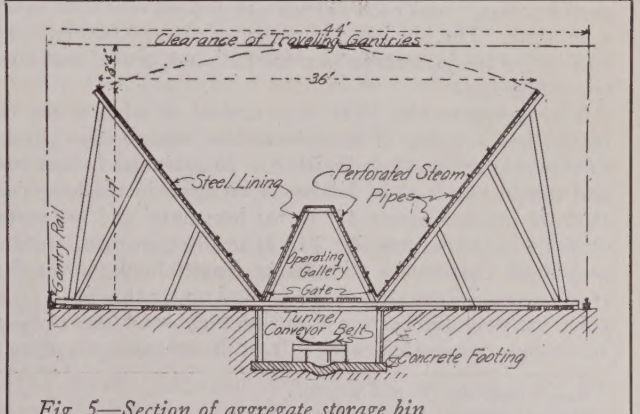


Fig. 5—Section of aggregate storage bin

Cement is received in 8,000 to 10,000-bag loads on scows which are moored at the west end of the slip at the foot of 14th St. It is unloaded by the shipper, who places the bags on a conveyor 100 ft. long parallel to the end of the slip and to the storage house. At one end the conveyor automatically delivers to a second conveyor 50 ft. long at right angles to the first that, in turn, automatically delivers to one end of the charging conveyor 125 ft. long that, at the opposite end, rises on an incline 25 ft. long that terminates above the cement platform dumping into chutes from which the bags are removed by two men and emptied into the Butler proportioning batchers that can be filled and discharged their contents into the mixers in three seconds.

The cement conveyors are operated at speeds of 73, 87 and 97 ft. per minute, respectively, and ar„ all of the Haiss slat type[10]. These speeds are just sufficient to supply both mixers running continuously at the rate of two 6-bag batches per minute if the bags are spaced 8 ft. apart on the belt. If only one mixer is running, the bags are spaced 16 ft. apart. This system permits the bags to be delivered directly from the scow to the mixer, or to storage, or to both simultaneously. The storage house, 120 ft. long and 40 ft. wide, has a capacity of about 25,000 bags, which, when piled close to the conveyor, can be handled as fast as the scow is unloaded, or as the mixer requires, by two men when the bags are piled close to the conveyor. When they are piled farther from it, four men may be required to take the extra steps.

As fast as the cement bags are emptied on the charging platform, they are delivered through chutes to 2 bag-shaking machines, each driven by a 1-h. p. electric motor. Bags, suspended in concrete pits under these machines, receive the cement salvaged, which amounts to about ½% of the total cement handled. The empty bags are bundled in a baling machine.

All sand, gravel and combined aggregate are delivered on 450 to 650-yd. barges which are moored to the 300-ft. north side of the slip. The barges are trimmed when loaded, and the quantity of aggregate is determined by measuring and computing the volume.

Adjacent and parallel to the side of the slip is the aggregate storage bin, 220 ft. long, that is spanned by 2 steel gantry travelers, each 30 ft. long, operated on a 44-ft. gauge track 260 ft. long that extends beyond one end of the bin to command a storage area there. One gantry is equipped with 2 stiff-leg steel derricks, having 65-ft. booms of 10-tons capacity operated by two 75-h. p. Clyde hoisting engines[11] with three drums and swingers. The other gantry has 2 stiff-leg wooden derricks with 73-ft. 10-ton booms operated by two 75-h. p. Lidgerwood 3-drum hoisting engines[7] with separate swingers. The gantries are equipped with three 1-yd. Blaw-Knox buckets[12] that unload sand and gravel from scows moored in the slip. The reinforcement steel, some of it being 1¼-in. square bars 60 ft. long, is handled in bundles, and is stored on the north side of the aggregate bin.

One or two derricks of either gantry can be operated on one or two scows; they are equipped with 1-yd. Blaw-Knox clamshell buckets,[12] and each derrick can unload one scow in one 8-hr. shift. The bin has a capacity of about 3,000 cu. yds., and is divided into three sections for sand, gravel and combined aggregate.

The aggregate bin, 17 ft. deep and 36 ft. wide at the top inside, has a lining of horizontal 2-in. square edge planks. the lower portion covered with No. 20 galvanized sheet steel and spiked to 3 x 12-in. beams 24 in. apart in the long sides that are inclined nearly 45° to the horizontal and are seated on 6 x 8-in. transverse sills 2 ft. apart that, in turn, are supported on continuous grillages of longitudinal planks that cover about ⅔ the area of the ground under the bin.

On the walls and bottom of the bin there are 4 lines of ¾-in. steam pipe, perforated every 2 ft. with extremely small holes made by drilling partly through with a very fine bit and then punching the remainder of the distance with a needle point. A similar provision is made for the charging hopper over the concrete mixers. The two bins together are equipped with about 4500 lineal ft. of perforated pipe, which, with the 600 ft. of branches are connected to the 125-h. p. boiler that is provided to furnish steam and prevent freezing of aggregate.

Instead of being braced by horizontal through tie rods, the inclined sides of the bin are supported by exterior struts that are framed into the side pieces and into the sills. The bottoms of the side walls are about 9½ ft. apart where they intersect interior walls inclined in the opposite direction to make a covered passageway over the center longitudinal conveyor tunnel. They form with the inclined outer sides a W-shape cross-section that concentrates the load on both sides of the sheeted tunnel, 5 ft. deep, that has a concrete floor slab 10 ft. wide.

A continuous working platform over the tunnel permits one attendant to operate the levers of thirty 16 x 20-in. radial gates staggered 7 ft. apart that were specially designed and built for this job by the George Haiss Manufacturing Co. The gates distribute the sand and gravel on a conveyor belt 30 in. wide and 250 ft. long that is dished about 6 in. and operates at a speed of 240 ft. per minute, delivering to either or both of the two vertical bucket elevators 50 ft. high running at 97 ft. per minute and either one of which can deliver 130 cu. yds. per hour to the mixer bin. The elevators are of special design with manganese steel chains, hardened steel sprockets, and cut steel gears.

The elevators are entirely enclosed so that all material that may chance to be spilled from the buckets drops to the bottom of the special steel boot, where it is automatically reclaimed by the buckets whenever the elevator is in operation. These elevators are installed on an independent braced timber frame and discharge through swivel chutes that permit sand and gravel to be delivered directly into the bin, or to a 30-in. horizontal conveyor belt 25 ft. long that, at the opposite end, discharges over a movable apron delivering to

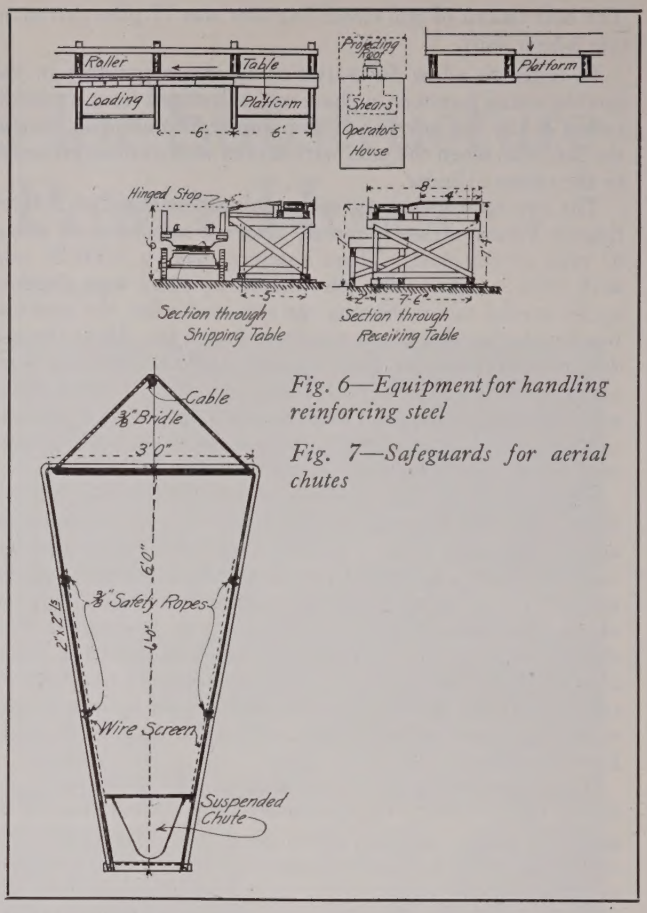


Fig. 6—Equipment for handling reinforcing steel

Fig. 7—Safeguards for aerial chutes

[10]George Haiss Mfg. Co., New York City.
[11]Clyde Iron Works Sales Co., Duluth, Minn.
[12]Blaw-Knox Co., Pittsburgh, Pa.

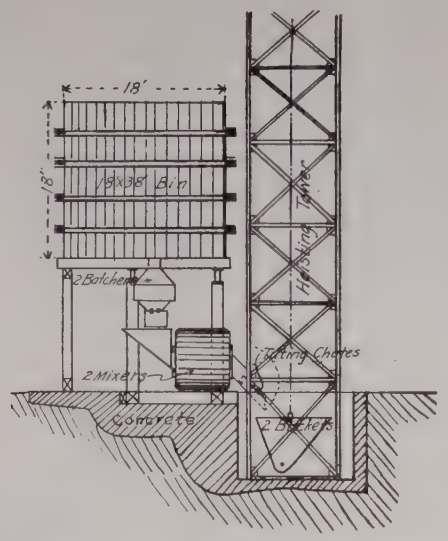


Fig. 8—Detail of mixing plant and main hoisting tower

either of two sections of the mixer bin. All the conveyors, elevators, etc., of the aggregate and concrete handling plant are of the Haiss type and are operated by standard 5- 10- and 15-h. p. electric motors, of which there are seven installed, providing an extra one of each size immediately available in emergency, all of them being interchangeable. There are also about 10 other electric motors of 5 to 25-h. p.

The mixer bin, 14 ft. wide, 38 ft. long and 18 ft. deep inside, is made with 2-in. planked vertical walls thoroughly braced with four tiers of horizontal ties, each having two 1⅛-in. longitudinal and five 1¼-in. transverse screw rods, engaging pairs of horizontal yoke planks on the outside. The bin is heated in cold weather by live steam from a bottom gridiron and three wall lines of perforated pipe. The horizontal bottom of the bin, about 17 ft. above the surface of the ground, is supported on one 12 x 12-in. timber girder and two steel girders, each composed of a pair of 20-in. 81-lb. I-beams, all carried on 12 x 12-in. vertical posts.

The mixer bin, bucket elevator and hoisting towers have a heavy, continuous reinforced concrete footing. The towers set in the bottom of a pit about 7 ft. in greatest depth and with maximum dimensions of 10 x 28½ ft.

The mixer bin is divided by 2 transverse partitions into a center compartment for sand and 2 end compartments for gravel, any or all of which, of course, may be filled with combined aggregate if required. Two openings 18 in. square in the bottom of the gravel bin and one in the bottom of the sand bin are commanded by steel gates and deliver to the Butler batchers over the charging hoppers.

They are operated by hand and instantly deliver the exact required amounts of aggregate to the two 1-yd. Koehring mixers,[13] each driven by a 25-h. p. electric motor at a speed of about 15 r. p. m. This automatic supply and measurement of aggregate eliminates all labor and insures high efficiency of the plant and uniformity of controlled product.

The mixers discharge through pivoted chutes to buckets at the foot of twin Insley steel hoisting towers[14] 240 ft. high and 15 ft. apart on centers that are thoroughly braced together and are guyed at each of six points with a set of six steel wire ropes making angles of approximately 45° with the horizontal. The buckets are hoisted by 2-drum mine engines, operating by 100-h. p. electric motors. They are equipped with powerful friction clutches that will hoist a load with not more than 10 lbs. pressure on the hand lever. They are operated by bell signals for lowering or stopping. A mark on the line indicates when the bucket reaches the hopper, and the operator can see when it arrives at the bottom of the tower. The great height of the towers is the limiting factor of production. The loaded bucket can make one round trip in about 45 seconds.

A special hopper is fixed on the hoisting tower about 15 ft. above the surface of the ground to permit concrete to be readily delivered to wagons or carts for distribution to places inaccessible by the chutes.

Electric signals are provided that connect the cement house, the aggregate storage and the mixer platform to the operator in a room at the end of the aggregate bins where there are installed 8 switches controlling all of the different motors driving the aggregate, cement and concrete machinery. A drop indicator is used to signal "stop" or "start" so that any part of the work can be instantly controlled independently of the rest. The different stations also have telephone connections with each other and with the operators on the concrete mast and in the pit so that instructions can be transmitted instantly to govern the amount or consistency of the concrete. The concrete is usually mixed stiff enough to crown a little in the hoisting bucket and generally flows without difficulty through the chutes inclined about 1 vertical to 2.7 horizontal. Water is admitted directly to the mixer from a receiving tank equipped with a Koehring automatic measuring valve[13].

The tops of the towers support 2 high line spouting cables. Each of these cables carries a maximum suspended load of about 15 tons and extends to the top of an American Hoist and Derrick Company's steel mast[15] 115 ft. high that is seated on a pyramidal wooden tower 20 ft. high, 5 ft. square at the top and 15 ft. square at the base. Each has four 12 x 12-in. inclined corner posts, secured by top and bottom scabs to

Fig. 9—General view of material handling plant showing gantry crane structures and unloading derricks, material storage bins, conveyors, etc.

16 x 16-in. horizontal timbers. The upper timbers support a 5 x 5-ft. solid platform of 12 x 12-in. timbers receiving the derrick base. The lower timbers are connected by scabs to groups of the regular foundation piles that will eventually be covered by the 15-ft. concrete floor slab. The corner posts are securely X-braced with 6 x 12-in. diagonals on every face.

The mast is made straight and is equipped with a 100-ft. tapered boom of 10 tons capacity at full radius. Both mast and boom are made in three field spliced sections and have lattice angles with flattened ends. The cast-steel foot block is extra large and its sheaves have heavy bronze washers.

The cement, aggregate and concrete handling plant was

[13]Koehring Machine Co., Milwaukee, Wis.
[14]Insley Mfg. Co., Indianapolis, Ind.
[15]American Hoist & Derrick Co., St. Paul, Minn.

designed and the equipment selected by the general contractor's staff in conference with the Ginsberg-Penn Co. and the R. E. Brooks Co.

Both cables are parts of an undivided 2200-ft. length of 2-in. steel cable, which is continuous over the top of the hoisting tower and over the top of each steel derrick mast whence it is inclined downwards to special anchorages. It will be stressed far below its capacity and being of full continuous length will have a high salvage value for cable way or other service. Besides this high line cable, there was used for rigging derricks, hoists and other equipment in the general installation ½-mile of 1½-in. and about 11 miles of ½ to 1⅛-in. steel cable.

The derrick masts are located about 330 ft. apart on a line substantially perpendicular to the river-front, and each of them is equipped with a 100-ft. boom carrying a counterweighted Insley truss[14] 50 ft. long, from the outer extremity of which there is attached when necessary a 30-ft. section of pivoted chute with a folding steel tripod about 15 ft. high attached to the end, from which the concrete is spouted to still more remote positions.

From the high line cables between the hoisting tower and the masts there are suspended in the usual manner standard 20-ft. sections of concrete chutes discharging into circular mast hoppers that permit the mast and hopper to revolve about 350° carrying a spouting radius of about 200 ft. divided into three revolving sections and enabling the entire area of the lot to be commanded by the chutes. The cable spans are respectively 305 and 290 ft. and their chutes, together with those operated by the derricks and counterbalanced trusses are all of the standard Insley type[12] and aggregate about 1,000 lin. ft.

When the two 1-yd. Koehring mixers[13] are running to capacity, both of them pouring into a single chute, a steady stream of concrete about 7 in. in diameter is delivered that produces heavy dead load stresses in the system and makes the handling of the terminal chutes heavy work. As large unit stresses may be produced in the counterweight trusses by the maximum loads, and as they might possibly be subjected while under strain to serious impact from accidental causes, the trusses have been made extra strong by transverse horizontal bottom chord bracing and by the insertion of frequent spreaders, that give them abundant strength to resist any ordinary impact.

When the chutes are running full of concrete, a slight irregularity, congestion, or obstruction may cause the concrete to accumulate, pile up against the cross braces and be thrown overboard with a possibility of falling on and seriously injuring workmen beneath. To avoid injuries from this cause, the suspended cableway chutes have been provided with angle iron trapezoidal yokes about 7 ft. high, that engage the bottoms of the chutes and are hung by light wire rope bridles from the suspension cable at intervals of about 20 ft.

The legs of these yokes are connected, parallel to the chute, with panels of heavy wire netting that prevent the possibility of anything but thin mortar falling from the chutes. They also serve as safety barriers for one man stationed at the top of the hoisting tower and another at the top of each derrick mast who at once proceed along the chute to the point of difficulty if any obstruction arises to the flow of the concrete. A third man climbs up from the lower end if obstructions occur in the chutes carried by the counterweighted trusses. It is estimated that when the chutes are running full of concrete, the suspension cables are loaded about 90 lbs. per lin. ft., and that the hook load on the ends of the derrick booms is about 26,000 lbs.

At the top of the tower the chutes are connected by pivoted sections and gates so that the concrete may be instantly shifted from either hoisting bucket to either chute, thus enabling all of the concrete to be delivered through either chute or divided between both of them. With this distribution system 1,000 yds. of concrete can be placed in the 8-ft. thick foundation slabs by a very small force in one 8-hr. shift.

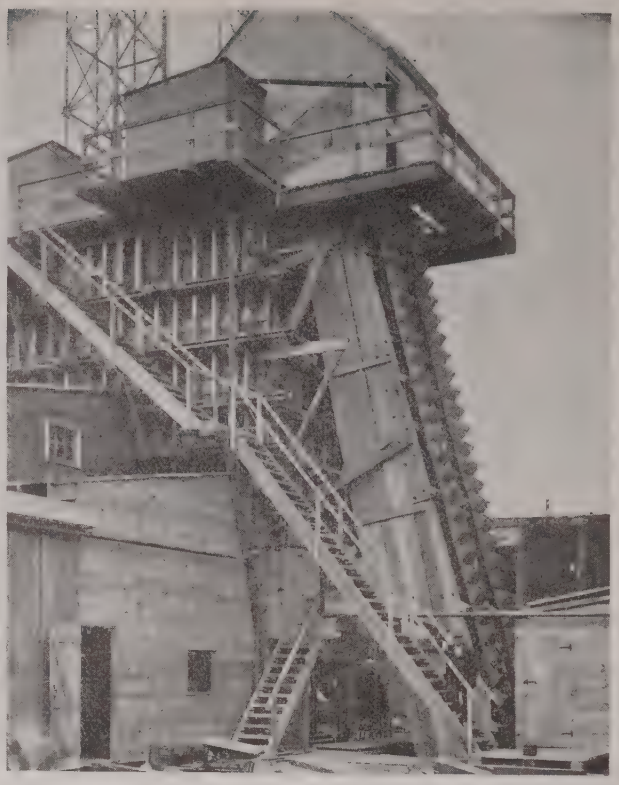


Fig. 10—General view of bucket elevators showing mixer bin construction details

The total weight of each suspension cable, alone, between anchorages is about 6200 lbs. Very careful work was required to hoist and secure it and to give it the proper adjustment. Two hoisting engines were required to adjust it to the necessary initial tension, amounting to probably 18 tons before the cable was made fast to its anchorage. The stresses and deflections were carefully calculated, but as no means were available for measuring them, the adjustments were made wholly as a matter of judgment by the engineer and were so well done that when the chutes were suspended from the cables, they assumed a very regular outline slightly crowned in the middle that, under loads, flattens out almost to a straight line.

Anchorages for the suspension cables, for the derrick guys and for the numerous guys to the hoisting tower are provided chiefly by seven special dead men located beyond the limits of the concreting area, and elevated to a minimum height of about 7 ft. above the surface of the ground, which, added to the slope of the tower guys that is never less than 1:4, avoids all obstructions and interference with operations throughout the area. Some of these anchorages receive as many as 10 guys and are subjected to a displacing strain estimated at not less than 90 tons maximum.

Stability for this service is afforded by specially designed and well braced ballast boxes in pits 3 or 4 ft. below the surface of the ground. A vertical transverse frame, 10 or 12 ft. high, is braced to a pair of longitudinal sills (parallel to the general direction of the guys) that are seated on a plank grillage in the bottom of the pit. A framed bent making an angle of 45° with the vertical is attached to the foot of the vertical transverse bent, its horizontal transverse cap is thoroughly braced to the rear end of the sills and affords intermediate bearing to the guys or their bridles that are there deflected to a direction only a little inclined from the vertical and then continue to their connections to the bottom sills. The arrangement, serving practically as a knuckle joint, provides for rapid downward deflection of the guy.

The floor of the ballast box is laid on top of the longitudinal sills and its planks project beyond the sills to the light, vertical side walls, carried up sometimes above the top of the

transverse frames and in all cases thoroughly secured by several tiers of through ties made from old wire cable. The largest size ballast box has a loading capacity of about 2200 cu. ft., equivalent when filled with closely packed stone to a weight of about 110 tons that resists the pull on the guys, estimated at a maximum of 90 tons under extreme conditions, not only by resistance to transverse motion on the ground, but by resistance to overturning around the extremity of the fills as a pivotal point, which develops a considerable advantage to the increased lever arm.

About 2,000 or 3,000 tons of reinforcement steel is delivered to a receiving platform about 6 ft. wide, 17½ ft. high and 42 ft. long with transverse bents 6 ft. apart that extend about 2½ ft. beyond the south side of the platform to carry 6-in. gas pipe rollers 18 in. long, over which the bars are rapidly pushed to a roofed shears on the axis of the roller track. On the south side of the rollers working platforms about 5 ft. high are placed in alternate panels.

Beyond the shears the roller track is extended 54 ft. with loading skids 6½ ft. wide on the south side. The horizontal receiving platform is 4 in. higher than the roller tops with connecting short inclined skids that are seated on the caps of the transverse roller bents and at the lower outer ends are provided with hinged stops 10 in. wide which may be lowered to allow the bars to slide off auto trucks or cars alongside.

Between the loading skids and the rollers, near the shears, is a horizontal measuring strip 10 in. wide that is marked off in feet and inches and has an adjustable stop. This arrangement insures the rapid and economical checking and sorting of the reinforcement bars, most of which are used straight, the remainder are bent at the site around adjustable pins on a flat table by hand levers.

During the waiting time between the award of the contract and the commencement of active operation, the latter part of April 1924, a very complete and simple system of cost-keeping records was developed by the contractor, Frank W. Cudworth, chief engineer, who also designed the details for the installation of a large amount of special and standard construction equipment, thus providing in advance for safety, uniformity and economy of the preliminary operations and avoiding delays and uncertainties that would have obtained without such comprehensive operations.

Concrete Brick Facing and Trim on Kingston, Pa., School

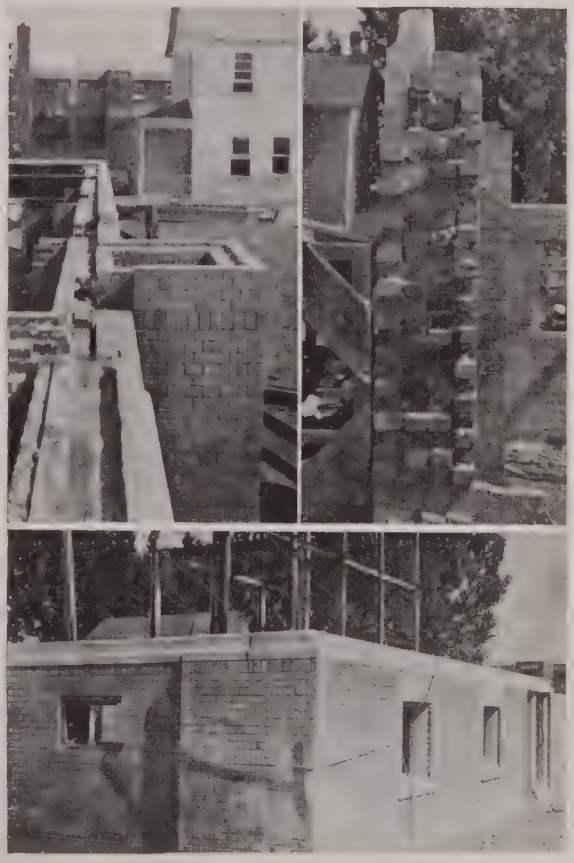
The pictures show the new Kingston, Pa., high school, in which construction is an unusual reversal of the order of things structural.

The wall construction below the water table is of gray concrete brick backed up with clay salmons. Above the water table the wall construction is of red concrete brick (colored throughout) backed up with Dennison interlocking (clay) tile.

The concrete brick were manufactured by F. L. Schott, Kingston, Pa., who has a thoroughly modern products plant. Sills, lintels, water table and other trimstone are of precast concrete with machine tooled surfaces, manufactured by the Onondaga Litholite Co., Syracuse, N. Y.

Mack and Sahm, Wilkes-Barre, are the architects and W. B. Richards, Wilkes-Barre, the builder.

The architects had an effect to produce, to get the most building for the least cost. Clay common brick was $17.00 and gray concrete brick for facing below the water table was very attractive at $22.00 per thousand. The red concrete brick above (Mr. Schott used Schope process) were cheaper, quality and color considered, than any face brick to be had.



While these pictures of the Kingston, Pa., school give no hint of color values, the construction views do show something of the good true edges of the gray concrete brick which is the face brick below the water table

Forms for Reinforced Concrete Building Construction*

Column and Floor Forms—Framing and Releasing

By J. A. Turner
Turner Construction Co.

Preliminary to a discussion of details in reference to the above subject, it is necessary that a summary be made of the general items of costs in connection with formwork.

In general the total cost of formwork to any contractor on any concrete job will be made up of the following items:

1. Cost of the lumber used and this is dependent upon
   - A Economical design of forms.
   - B Maximum number of uses of forms.
   - C Minimum amount of replacement after each set-up.
   - D Salvage value at end of job.
2. Labor expended—this cost is dependent upon
   - A Cost of making into the shapes or units to be used.
   - B Cost of setting up in position for concreting.
   - C Cost of taking down or stripping after concrete has sufficiently hardened.
   - D After stripping, the cost of handling and hoisting and placing for the next set-up.

It is evident that the details to be followed in making up the form units is going to have a very decided bearing on all of the above items. Forms so constructed that they can be easily released and reset will effect savings in both the amount of lumber consumed and the labor expended.

Considering items 1 and 2 we find that in designing the forms they must fulfill the following requirements:

- A Substantial and reasonably unyielding but as light in weight as possible.
- B Few units as possible but no unit excessively heavy or cumbersome.
- C All corners and intersections of units so framed that the units can be easily released saving labor in stripping and carpenter work in rebuilding. Solid square intersections must be avoided.
- D Provide vertical wooden keys at intersections of beams with columns and with girders. Where beams frame into girders, keys required on one end only. Keys to be of uniform size in order that same can be sawed out on power saw.

The above points are those requiring careful study on all jobs. Now to get down to concrete examples, let it be assumed that we have a standard flat slab job of say 8 stories with typical floors. Generally one full floor of forms will be constructed and used eight times unless the floor area is exceedingly large and sufficient time is available to use forms twice on each floor. However, sufficient vertical supports must be provided for several floors.

In the making of the one floor it is necessary that the units be constructed in order that those that can be removed the earliest be framed to release ahead of the balances of the forms. This is essential to make the maximum amount of speed. The order of removal is as follows:

1. Column forms
2. Forms supporting depressed sections around column heads
3. Forms for exterior beams
4. Forms for main slab

The interior columns are usually of metal and the exterior of wood construction. The exterior columns are easily released if keys are provided around the beam sides intersecting them. Detail is shown in Fig. 3.

The forms supporting depressed sections around column heads are usually supported on separate shores which can be safely removed earlier than the main slab shoring. The details of this portion of the forms are shown in Figs. 1, 2, 3. These details can be varied somewhat but the object must be to permit easy and rapid removal in order that this portion of the forms be erected for the next set-up by the time the removal of the main slab forms are started. The exterior beam forms are easily released by removing the shores under one beam at a time and reposting immediately. To release this form quickly and economically it is necessary that vertical keys be provided at each end of the beam side where it intersects the column and the bottom be cut slightly shorter than the neat distance from concrete to concrete of the columns and with a slight bevel, as detailed on Fig. 4. By this procedure the beam forms can be kept intact in one unit saving loss of material through breakage and mislaying and also carpenter labor in erection. This unit can be hoisted and set in position by unskilled labor ready for the mechanics to secure in accurate location and replace the keys.

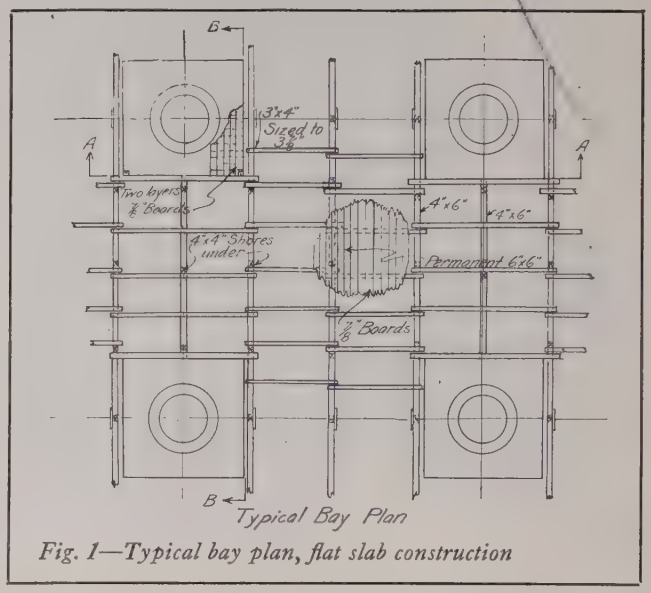


Fig. 1—Typical bay plan, flat slab construction

The supports for the main portion of the slab should be made up similar to that shown on Figs. 1, 2, and 3. The 4 x 4-in. posts are handled singly as are also the 4 x 6-in. capping plates or ledgers. These are hoisted and set up by carpenters ready to have the panels landed and placed in almost correct position by unskilled labor. The ⅞-in. decking is made into panels using the 3 x 4-in. spreader supports as battens. These 3 x 4's extend from one 4 x 6 to the next and when the panels are made up it is necessary to arrange for staggered spacing of 3 x 4's in adjacent panels in order that the 3 x 4's may secure full bearing on the 4 x 6-in. plates without foulding one another.

Panels should be made the length of the span from column to column, that is, to extend from center line of one column to the center of the next. Panels between heads, of course, can only be the length from depressed slab to depressed slab. A convenient width of panel and spacing of 4 x 6-in. plates is usually from 4 ft. 6 in. to 6 ft. 6 in. Beyond 6 ft. 6 in. the panels become too unwieldly and heavy for laborers to handle.

With the use of this system of formwork it is essential that

*From a symposium on forms by members of Committee C-4, American Concrete Institute. Published by courtesy in advance of copyrighted *Proceedings*, Vol. 21, 1925.

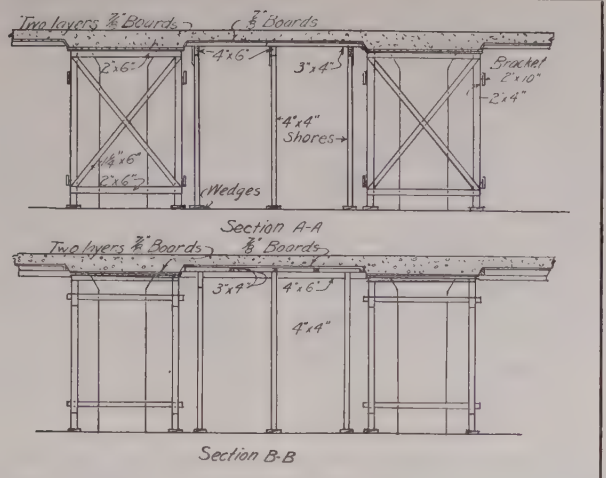


Fig. 2—Sections AA and BB of Fig. 1

a 6 x 6-in. permanent shore be placed in the center of the span before the concrete is poured to remain as the permanent shore when the 4 x 4-in. supports are removed. This 6 x 6 is placed directly against a small panel about 12 in. square, cleated to the main panel in order that all forms except the small panel over the 6 x 6 may be removed without disturbing the 6 x 6. One bay of forms is removed at a time and an additional 6 x 6 is placed in the center of the band as soon as the panel is lowered to give permanent support for the slab at these points. This system permits the re-use of all of the floor of forms including the 4 x 4-in. shores except for the re-posts under the exterior beams and the 6 x 6's. It also meets the requirements for economy as previously outlined. The unit cost per square foot for unskilled labor expended is slightly increased but the expenditure required for skilled labor at high rates is materially reduced—unskilled labor not only performing all stripping and hoisting work but also doing a great part of the setting in place. A large saving is effected in lumber used, as the amount to be purchased for *replacement*

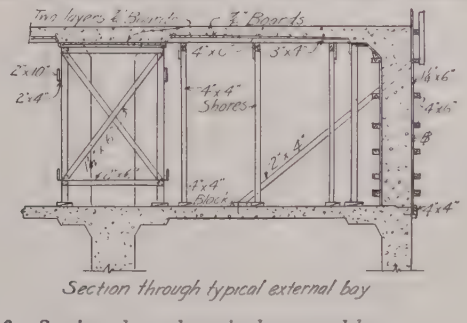


Fig. 3—Section through typical external bay

after the forms are made complete for the first set-up is almost negligible. As previously stated, however, the forms must be constructed with bevel cuts and keys in the beams in order that the forms may be released without excessive prying with bars which is expensive both in labor used and lumber destroyed or damaged requiring mechanics to patch.

Beam and Girder Construction

Everything that has been said before applies more forcibly to beam and girder construction than to flat slab construction. In beam and girder work there are more vertical points of contact in the forms and consequently more places to bind and more necessity for keys. It is also essential that the units be kept intact. If beam and girder sides are to be taken apart from the bottoms, labor must be expended to take them apart and carpenter work is created in the nailing together again. It is evident also that if the ⅞-in. decking is not made

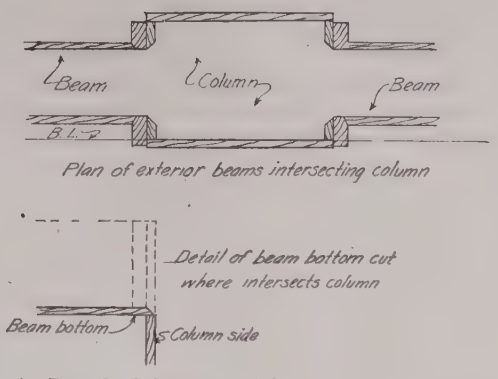


Fig. 4—Detail of framing of beam form at intersection with column

into panels much lumber will be lost or broken, requiring the purchase of additional lumber and the spending of additional labor to make the replacements.

It is an established fact that anywhere from 20% to 40% more lumber will be used on an eight story beam and girder job if the columns, beams, girders and deck forms are not made into units and kept intact. It will be found that additional lumber will be needed to complete every floor of forms and on top of the purchase price of the lumber must be added the labor expenditure of receiving, hoisting and using of this lumber.

This wasteful expenditure can be eliminated by making the columns, beams, girders, and deck panels into complete units. But as stated above, these units can only be kept intact and readily released when stripping providing keys have been constructed.

* * *

Column Forms

By L. H. Usilton
General Superintendent, Barney-Ahlers, Co.

In the design of column forms an effort is directed toward securing the maximum economy possible without in any way injuring the appearance of the finished work. This requires as careful preliminary study in the early stages of preparation for the job as is given to the general procedure of the work. The plans and specifications must be carefully surveyed, materials purchased and arrangements made for storing and handling so as to avoid loss or damage.

The requirements necessary to secure a good appearance are that lumber must be piled evenly so that it will not warp or twist, that in making, the different pieces be wedged tightly so that subsequent drying will not shrink causing numerous fins to form, and that after making an effort be made to keep the lumber damp to prevent such shrinking. Naturally, the different pieces must be of sufficient strength to take the concrete pressures without permitting any bulging or shifting. It is well to limit the width of sheathing to 5½ in. or 6 in. since wider pieces shrink a great deal more and leave heavier fins. Also, nails should not be driven home in the sheathing since subsequent wetting causes the wood to swell, countersinking the head and leaving protuberances in the face of the column corresponding to the nail head.

Cost in general consists of labor, material and indirect charges whose importance depend on the influence the final form design may have on the remainder of the work. The direct labor and material costs are not difficult to ascertain but the matter of gauging the influence of the use of a certain type of column on the job may be very difficult. Those columns cheaper in themselves, may cost more in the long run by delaying the progress of the work or by requiring extra work in making connections.

Direct labor costs are those involved in receiving and storing

the necessary materials, handling to the job mill and performing the operations required there (boring, ripping, cutting), making into units suitable for easy handling, transporting to place, erecting, bracing, and tightening, removing, repeating and handling and erecting cycle as often as necessary, then the final handling, breaking up and disposal.

Direct material costs arise from the purchase of lumber, nails, grease, bolts, washers, nuts, clamps, sheet metal and the various tools required to do the work.

The usual design of exterior column form consists of vertical sheathing of tongue and grooves material nailed fast to yokes of a size sufficient to take the pressure of the concrete. These yokes are usually 3 x 6 in. or 4 x 6 in. on the long dimension of the column and extend far enough past the form and yoke on the short side of the column to take bolts through holes bored in the long yoke, and yet admit a wedge to be driven between the bolt and short yoke close up to bring pressure on the short side. These forms are supported on brackets bolted to the pedestal or column immediately below, the bolts being stud bolts imbedded in the concrete when poured previously. At the top provisions are made for connecting up with the floor and with the exterior lintel. All connections are made with small loose pieces called keys which, removed first, give the clearance required for easy removal. Special attention must be given to the lining up of the top of the column where lintels come in on the outside and a bracket on the inside. Here bolts are not practicable and a vertical cantilever is used bolted through the top yoke lying below the lintel with the cantilever extending up to top of lintel to take the pressure of concrete and also running far enough down (one or two yokes' distance) to take care of any stresses arising. These vertical pieces are usually 4 x 6 in. and two per column.

It is usual to add small triangular or rounded pieces to all square corners in order to eliminate breaking off when removing forms. These vary from 7/8 in. to 2 in., depending on the size of the sections and do not appreciably lessen the concrete yardage. Also, small "recesses" are added to provide for sash or else for brick or tile to tie into. These are made with beveled edges so that they may be removed easily.

Interior columns are generally of round section with flaring capital and depressed slab section around the top. Forms are usually of metal and it is always necessary to take up with the metal form contractor the connections necessary for his columns. These vary considerably and provision must be made in the floor forms to take the head arranged for. These forms consist of metal sheets built to radius desired with rings or clamps of proper bend at sufficient close spacing to preserve the lines of the columns. The flaring capital is made of various sheets and then fastened to the shaft and a ring placed at the junction. Some of these forms are supported on the lower floor; others are suspended from the floor form above. Provision must be made, however, to specially support the depressed head which may be carried down by the weight of concrete in pouring.

Variations in exterior column forms are made in many ways depending on the particular conditions existing on the job. Yokes may be left loose, battens being used to hold the sheathing together making lighter units to handle but more pieces to handle and perhaps lose. Instead of bolts, wooden clamps may be used with cleats holding at the corners and wedges added as the column is reduced. The metal clamps with a set screw gripping a rod may be used instead of bolt and nut. Adjustable metal clamps for any size of column may be substituted for yokes. These make a much lighter column and eliminate some labor in making up. Also, on wide columns, in order to avoid very heavy yokes a vertical piece may be connected by bolts through the center of the column with another on the opposite side. Where columns are to be moved vertically the weight does not have much influence on labor cost. A winch will be used to pull up and a heavy column will come up as fast as a light one. Here there should be as few loose pieces as possible. Where, however, forms are to be lifted or handled by hand a study should be made as to just how they should be lightened, whether by loose yokes or by use of the clamps instead.

Interior columns may vary from the customary round metal to various shapes—octagonal, square or rectangular. Square or rectangular sections may be built similar to exterior columns except that the top connection to floor will probably be different. Octagonal columns may be made similar to square with triangular pieces fitted in corners to bring in four additional sides. Round columns or columns approaching round shape may be made of wood. Full round columns are difficult to reduce. Where, however, the forms are made of an alternate tangent and curve with the whole keyed in place and clamped by a chain, it is easy to reduce by ripping part of the width from the tangents.

In designing interior column forms, one point must not be lost sight of—when wood columns are used and are set up, a support true to line and grade is provided for adjacent floor forms. Where metal column forms are used this support (usually by wood horses) must be provided and enters into the cost of floor forms. Therefore, where metal columns sometimes show cheaper in themselves the extra work which is charged to floor may offset the advantage. This particularly applies to beam and girder jobs where round columns are used.

There are special cases of column design which may occasionally come up. Corner columns are usually L-shape and are made similar to typical column with corner blocked out. Columns against a wall must often be braced from the outside and stud bolts may be placed in floor below to hold a ledger for such bracing. Also, expansion bolts may be placed in the wall. The wall in itself may need bracing against concrete pressure. Columns built monolithic with wall are usually bolted through in one direction the other being braced against adjacent wall.

Bracing is usually formed of level bracing in both directions to next column and diagonal bracing at least at the end of every row in each direction. Diagonal bracing may be to base of nearest column or to blocks in floor secured by stud bolts.

In order to get an economical and straight job it is first necessary to take the plans and decide what set of forms is to be made up, then to figure each move in detail, these forms should make and what alternations are to be made. Occasionally concrete design may be altered to simplify this work. Forms are then planned to minimize alterations and handling and where these are necessary to do as easily as possible. As an example, if columns are to be reduced in size it is well to make the side with strips which can be knocked off thus eliminating hand ripping. Extra bolt holes should be bored in yokes by boring attachment on the saw so that they are not done by hand. Yokes should be laid out to minimize work when changes in length of column are made. On small jobs where there is no saw, recesses will sometimes cover a small opening in short side of the column and save ripping.

Having gone into this phase thoroughly it is necessary to order materials to fit. Price will sometimes determine decision but in general lighter woods with minimum of knots are selected. Materials are received as nearly accessible to railroad or road as possible—those to be milled, moved towards mill which movement should always be toward first set up, then made, greased and piled neatly or moved into place. In making, all connections should be made with provision for bevels or angles to give clearances that forms are removed and not wrecked, partticularly if they are to be used again.

Occasionally when there is much alteration on different floors, it may be preferable to have parts of different sets of forms moving them horizontal rather than vertical. After the construction plan is followed through it is then necessary to wreck and clean up whatever is left up. Cost of this

cleaning up and salvage value of material fit for reuse should be figured in cost of forms.

In addition to costs of material and labor there may be others to be taken into account. It would not be economy to save on column forms and lose a greater amount on another part of the job. For example, when metal forms are let by sub-contract—figures are usually low but in addition to item of cost given above of placing horses for support, the work of these men may be so slow as to slow up the job so that with the same organization much less work is turned out. Also, at the finish of a floor (forms) work may be a little slow for the carpenter gang and a number of columns may be set up before floor forms are ready to be removed. These are considerations which can be rated only as result of experience on other jobs.

Hard and fast rules cannot be laid down as it is only after a close study of all requirements of any particular job that forms can be planned. Speed, type of finish required, character and supply of labor, price of various materials, prospects of other work, size of job, all these must be taken into account. Sometimes in haste, forms are designed to be put up with no thought given to taking down, a costly procedure as is always proved. There are comparatively few important differences in construction of column forms which have much influence on the cost—the principal being the use or disuse of any of the various clamps on the market. Contractors using clamps point out that when cost of wood yokes, of labor, of cutting, handling and boring and making, of handling extra weight and of final wastage are taken into account clamps prove cheaper. Others claim that initial cost, loss of parts, lack of adaptability, and the fact that more pieces to be handled prevents their use. There can be no question that certain types will work out splendidly on certain jobs. Whether they are desirable or not is a question which the superintendent and carpenter foreman on any particular job must work out.

With many different cost systems in use by various contractors it is out of the question to decide that any device or method is economical without a close study being made or perhaps a trial on a small scale.

* * *

Adjustable Shores vs. 4 x 4 Wood Shores

By E. C. Harding
General Superintendent, Ferro Concrete Construction Co.

A comparison between adjustable shores and 4 x 4 wood shores is a very complex subject. Each construction project presents different problems in shoring the forms. The type of construction, story heights, sloping floors, etc. will not admit a general comparison. Shoring operations must be analyzed and studied. The unit operations will not vary materially on different jobs and different types of construction and a combination of these units will present totals that can be used for comparison. On account of these variables it is misleading at times to say that it costs a certain amount to shore form work. The following data are presented for the various unit operations.

Initial Costs

Adjustable Shores—Generally speaking there are two methods employed to take care of the initial cost to each job. The shores are either rented to the job on a per diem basis or each job is charged a predetermined percentage of the initial cost. The initial cost is made up of the following: Purchase price, depreciation, repairs, and a carrying charge. The purchase price depends upon the type of shore and will vary between $4.50 and $5.00. Depreciation is generally figured at 20% per year. One manufacturer of adjustable shores has made an analysis of the cost of repairs and finds that over a period of six years and a total of 17,000 shores among 17 users, 7c per shore per year is the average; this amount appears low and it is recommended that twice this amount be used. Six per cent is usually figured for carrying charge. Four by four-inch Shores—When 4 x 4-in. shores are used the material is generally charged to the job and the usable material left is salvaged at a certain percentage of the first cost. The other items entering the initial cost are wedges and splicing material, labor necessary to make up the shore the first time, and the labor necessary to splice out or cut off the 4 x 4-in. The cost of lumber varies in different parts of the country. Wedges cost about 4c per shore setting. Splicing material from 10c to 12c. To square both ends and cut to length costs 7c. To splice a 4 x 4-in. costs from 35 to 40c; to cut off 4c. The above figures are based on $1.20 per hour skilled labor. The average life of a 4x4-in. shore is seven shore settings.

Erection Labor

The erection labor per shore cannot be stated unless the type of construction, floor heights, sloping floors, etc. are carefully analyzed. A comparison between 4 x 4's and adjustable shores on a large number of different jobs shows that adjustable shores can be erected at a saving of 8 to 10% per shore erected.

Bracing—When using adjustable shores, fully extended, proper bracing is very essential and additional braces are necessary over the amount required in using 4 x 4's. It is recommended that "X-bracing" be used every 50 or 60 ft. both ways.

Types of Construction Where Adjustable Shores Are Not Suited—Adjustable shores can be substituted for 4 x 4-in. shores in shoring of forms in concrete construction. An analysis may show that 4 x 4's are as cheap if not cheaper than adjustable shores.

Requirements of an Adjustable Shore—In conclusion it is deemed advisable to enumerate the fundamental requirements of an adjustable shore.

Long Range of Adjustability—This is self-evident and is necessary on account of the limits to be covered. The range should include at least 95% of the shoring heights.

Safety in Use—No contractor can afford at any time to endanger his work or employees. He must be very careful to see that the operation of the shore does not involve a personal equation. It is necessary that the device be so constructed that there is absolutely no danger of setting it in such a way that it will not carry the load. The lock must preclude any doubt of the shore slipping when used in any and every possible manner for which it is intended.

Simplicity of Operation—Adjustable shores are erected by any one from common laborers to skilled mechanics, a great many of whom are not mechanically inclined and do not readily understand the operation of a device of this character. Any complicated mechanism which is not easily and quickly understood will be a serious handicap in its operation, and will very materially increase the cost of its use. The same crew of experienced men is not always available and in many instances the contractor must call upon men who have never erected an adjustable shore. The device ought to be a complete unit, as the correlation of several units involves increased cost.

Sufficient Strength—The device must be capable of supporting the superimposed load that it is designed to carry.

Weight—The unit should be a one man load or 70 lbs.

Adjustability in Place—This is an important feature as it is very often necessary to move the shore either up or down. The jacking device must be simple in construction and efficient in operation.

Construction of the Device—The investment in adjustable shores is rather heavy. The unit must be so designed and constructed to withstand the wear and tear to effect the expected life and number of usings.

The Properties and Use of Aluminate Cement

By Roger L. Morrison
ASSOCIATE PROFESSOR OF HIGHWAY ENGINEERING, UNIVERSITY OF MICHIGAN; AND DIRECTOR, MICHIGAN STATE HIGHWAY LABORATORY

Presented at the Eleventh Annual Conference on Highway Engineering at the University of Michiagn, Ann Arbor, on February 18, 1925.

Aluminate cement is made from limestone and bauxite, the latter material being high in alumina and taking the place of the clay used in the manufacture of portland cement. The outstanding properties of this cement are the very high strength which it develops in 24 hours and its power to resist the chemical action of sea water and certain underground waters encountered in tunnels. It is also stated that aluminate cement is less affected by freezing temperatures before it has set up than is portland cement.

Both American and European chemists have been investigating the possibilities of aluminate cement for approximately 20 years but it was first developed upon a commercial scale by M. Jules Bied, Technical Director of Ancienne Societe J. & A. Pavin de La Farge, France, and is being manufactured by this company under the name of ciment fondu. Apparently the first use of this cement was on railway tunnel work but it was brought to the attention of many engineers during the war when it was used in artillery foundations and for other work at the front where speed was of great importance. It is also used extensively in pavement repairs, particularly n Paris, and the present production of the La Farge Co. s about 200,000 bbls. annually.

Probably the first experimenting in this country along the lines of the development of aluminate cement was by H. S. Spackman but nothing was done commercially until last year, when the manufacture of aluminate cement was begun by the Atlas Lumnite Cement Co. As this is the only aluminate cement made in the United States at present, the investigations now being conducted at the University of Michigan are necessarily confined to that product.

This investigation was not begun until about three months ago so that our problem was to get as much information as possible in a short time. For this reason the tests are perhaps not as logically arranged, and are certainly not as complete, as they would be if the time had not been so limited.

The tests made to date include chemical analysis, specific gravity, fineness, soundness, and setting time of the cement, tension and compression tests of cement mortar, compression tests of concrete, bond between aluminate and portland cement mortar, and setting time of mixtures of aluminate and portland cement. In most cases, check tests using portland cement were made at the same time and by the same operators, as a basis of comparison.

The chemical analysis of a sample of aluminate cement was as follows:

	Aluminate Cement	Portland Cement[1]
SiO_2	8.50	19–25
FeO	18.34	2–4
Al_2O_3	37.24	5–9
CaO	31.60	60–64
MgO	1.13	1–5
SO_3	1.47	1–2
Loss	2.08	–4

[1]For comparison.

It will be noted that this cement is much higher in alumina and also in iron than portland cement, while its lime and silica contents are much lower.

The results of physical tests on several samples of aluminate cement were as follows:

Specific gravity—
Sample No. 1 ..... 3.137
Sample No. 2 ..... 3.128
Average 3.132
(A. S. T. M. portland cement specifications, Min. 3.10.)

Fineness— (Retained on 200 mesh sieve)
Sample No. 1 ..... 17.0% retained
Sample No. 2 ..... 6.0% retained
Sample No. 3 ..... 5.7% retained
Average ..... 9.6% retained
(Portland cement specifications, maximum 22.0%.)

Soundness—O. K.
Normal consistency—21.6.

Setting time—
Initial, 6 hours 38 minutes.
(Portland cement specifications, minimum, 1 hour,)
Final, 8 hours, 8 minutes.
(Portland cement specifications, maximum, 10 hours.)

Tension tests were made using standard sand under varying curing conditions which would most nearly represent construction conditions, also a standard test using natural sand. Table 1 shows the results of these tests.

TABLE I—TENSION TESTS, 1:3 MORTAR
Pounds per square inch.

Age	Standard Ottawa Sand				Natural Sand			
	1 day moist air, rest dry		2 days moist air, rest dry		3 days moist air, rest dry		1 day moist air, rest water	
	Lumnite	Portland	Lumnite	Portland	Lumnite	Portland	Lumnite	Portland
1 day	360	113	....	....	....	....	492	165
2 "	320	127	415	183	....	....	....	....
3 "	....	....	333	187	....	....	673	292
4 "	388	172	353	152	363	178	....	....
7 "	....	....	....	....	....	....	635	352
28 "	....	270	382	332	507	413	690	540
83 "	417	369	395	....	....	....	....	....

The mortar compression tests were made upon 2 in. x 4 in. cylinders and 2 in. x 2 in. cylinders, the composition and curing conditions being the same as in the case of the tension tests. The last set of briquettes and cylinders was broken at 83 days because if they ran longer, the results would not be available at this time. Results are given in table II and portland check test results in table III.

TABLE II—COMPRESSION TESTS, 1:3 MORTAR
Aluminum Cement
Pounds per square inch.

Age	Standard Ottawa Sand				Natural Sand			
	1 day moist air, rest dry		2 days moist air, rest dry		3 days moist air rest dry		1 day moist air, rest water	
Days	2x4 cyl.	2x2 cyl.	2x4 cyl.	2x2 cyl.	2x4 cyl.	2x2 cyl.	2x4 cyl.	2x2 cyl.
1	6125	6340	....	....	....	....	6072	7144
2	....	6414	5624	5668	....	....	....	....
3	....	....	5730	6656	....	....	6252	8211
4	6220	6741	5605	5621	5297	6581	....	....
7	....	....	....	....	....	....	4798	7167
28	....	7195	....	7131	....	7112	6082	9145
83	....	7094	....	7097	....	....	....	....

TABLE III—COMPRESSION TESTS, 1:3 MORTAR
Portland Cement (For Comparison)
Pounds per square inch.

Age	Standard Ottawa Sand				Natural Sand			
	1 day moist air, rest dry		2 days moist air, rest dry		3 days moist air, rest dry		1 day moist air, rest water	
Days	2x4 cyl.	2x2 cyl.	2x4 cyl.	2x2 cyl.	2x4 cyl.	2x2 cyl.	2x4 cyl.	2x2 cyl.
1	647	677	....	....	....	....	843	1037
2	1047	1167	1143	1183	....	....	....	....
3	....	....	1340	1483	....	....	2190	2342
4	1630	1650	1550	1863	1247	1747	....	....
7	....	....	....	....	....	....	3117	2610
28	2060	2163	2330	2457	2597	3120	....	3950
83	....	....	2667	2853	....	....	4257	3690

In making the concrete compression tests, a bank-run gravel was screened into separate sizes and then remixed in predetermined proportions so that the aggregate in the various cylinders would be as nearly uniform as possible.

Table IV shows the properties of the aggregate after it was remixed ready for use.

TABLE IV—PROPERTIES OF AGGREGATES USED IN CONCRETE CYLINDERS

Material—Bank run gravel, screened and remixed.
Weight per cu. ft.—122 lbs.
Voids—22.6%.
Abrasion test:

Plain Cylinders,	Test No. 1, % of wear	5.6
	Test No. 2, % of wear	6.7
	Average	6.2
Slotted cylinders,	Test No. 1, % of wear	10.7
	Test No. 2, % of wear	11.8
	Average	11.2

Objectionable particles—1.6%.
Mechanical analysis:

Screen	Percent Passing	Screen	Percent Coarser
1½ in.	100	100 mesh	97
1 in.	82	48 mesh	92
¾ in.	71	28 mesh	79
½ in.	54	14 mesh	72
¼ in.	37	8 mesh	67
8 mesh	33	4 mesh	63
10 mesh	32	⅜ in.	50
20 mesh	26	¾ in.	26
30 mesh	18	1½ in.	..
40 mesh	14		
50 mesh	7	Fineness modulus	5.46
80 mesh	4		
100 mesh	3		
200 mesh	0.5		
Clay and silt	1.5		

Table V shows strengths obtained using various mixes and slumps, all cylinders being cured in moist air.

Table VI shows strengths at 4, 5, 8, and 29 days under various curing conditions. Tables VII and VIII give the results of check tests using portland cement. All cylinders were 6 in. x 12 in. in size.

TABLE V—COMPRESSION TESTS OF CONCRETE
Aluminate Cement Cylinders, Cured in Moist Air
Strength in pounds per square inch.

Mix	Percent Cement	Slump	1-day	3-days	4-days	5-days	8-days	29-days
1:4:8	7.7	1 in.	843	....	....	....	....	....
"	"	4 in.	456	1589	1324	1242	1218	1111
"	"	6 in.	450	....	....	....	....	....
1:3:6	10.0	1 in.	2160	....	....	....	....	....
"	"	4 in.	1157	3137	2375	2344	2073	2325
"	"	6 in.	690	....	....	....	....	....
1:2:4	14.3	1 in.	4537	5035	5040	5091	4789	5109
"	"	4 in.	4187	4973	4747	5349	4615	4856
"	"	6 in.	3222	4626	4079	4495	3742	3943
1:2:3½	15.4	1 in.	5203	....	....	....	....	....
"	"	4 in.	4728	....	....	....	....	....
"	"	6 in.	4133	....	....	....	....	....
1:1½:3	18.2	1 in.	5731	....	....	....	....	....
"	"	4 in.	5052	....	....	....	....	....
"	"	6 in.	4523	....	....	....	....	....
1:1:2	25.0	1 in.	6449	....	....	....	....	....
"	"	3 in.	5491	....	....	....	....	....
"	"	6 in.	5846	....	....	....	....	....

TABLE VI—ALUMINATE CEMENT CYLINDERS—COMPARISON OF CURING METHODS

Mix	1:2:4	1:2:4	1:2:4	1:3:6	1:4:8
Slump	1 in.	3 in.	6 in.	3 in.	3 in.
Age—4 days.					
1 day moist air, 3 days dry air	5406	5092	4530	2589	1429
2 days moist air, 2 days dry air	5105	5160	4496	2549	1410
4 days moist air	5040	4747	4079	2375	1324
Age—5 days.					
1 day moist air, 4 days dry air	5289	5096	4967	2533	1447
2 days moist air, 3 days dry air	5846	5025	4520	2752	1459
5 days moist air	5091	5349	4495	2344	1242
Age—8 days.					
1 day moist air, 7 days dry air	5007	5498	3884	2431	1647
2 days moist air, 6 days dry air	5482	4855	3651	2479	1526
8 days moist air	4789	4615	3742	2073	1218
Age—29 days.					
1 day moist air, 28 days dry air	4679	4946	4139	2517	1583
2 days moist air, 27 days dry air	5338	4969	4011	2397	1552
29 days moist air	5109	4856	3943	2325	1111

RELATIVE STRENGTH ALL MIXES

	4 days	5 days	8 days	29 days	Average
1 day moist, rest dry	108	104	112	103	107
2 days moist, rest dry	107	106	109	105	107
Total time moist	100	100	100	100	100

TABLE VII
Portland Cement Cylinders, Cured in Moist Air
Strength in Pounds per Square Inch
(All 4-in. Slump)

Mix	Percent Cement	1 day	3 days	4 days	5 days	8 days	29 days
1:4:8	7.7	[1]	[1]	209	260	282	589[2]
1:3:6	10.0	95	561	....	544	662	1205
1:2:4	14.3	235	755	958	1144	1567	2705

[1]Broke before load was applied.
[2]Age 35 days.

TABLE VIII—CHECK TESTS ON PORTLAND CEMENT—COMPARISON OF CURING METHODS
All 4-in. Slump

Mix	1:2:4	1:3:6	1:4:8
Age, 4 days.			
1 day moist air, 3 days dry air	901	512	232
2 days moist air, 2 days dry air	1067	524	249
4 days moist air	958	....	209
Age, 5 days.			
1 day moist air, 4 days dry air	906	565	269
2 days moist air, 3 days dry air	1147	523	247
5 days moist air	1144	544	260
Age, 8 days.			
1 day moist air, 7 days dry air	1302	732	331
2 days moist air, 6 days dry air	1395	620	302
8 days moist air	1567	662	282
Age, 29 days.			
1 day moist air, 28 days dry air	1453	807	368
2 days moist air, 27 days dry air	2218	953	326
29 days moist air	2705	1205	589[1]

[1]Age 35 days.

RELATIVE STRENGTH ALL MIXES

	4 days	5 days	8 days	29 days	Average
1 day moist, rest dry	94	89	94	58	84
2 days moist, rest dry	105	98	92	78	93
Total time moist	100	100	100	100	100

TABLE IX—EFFECT ON SETTING TIME OF ADDITION OF PORTLAND CEMENT

Percent of Lumnite	Percent of Portland	Percent of Water	Setting Time					
			Initial			Final		
			(1)	(2)	Ave.	(1)	(2)	Ave.
100	0	21.4	6:00	6:45	6:23	7:50	7:00	7:25
90	10	23.0	4:09	3:55	4:02	4:54	4:45	4:49
85	15	23.4	3:00	2:45	2:53	3:50	3:20	3:35
80	20	24.4	2:40	2:50	2:45	3:40	3:45	3:43
75	25	25.0	3:23	2:40	3:02	4:23	3:25	3:54
67	33	26.0	2:23	2:15	2:19	3:53	3:15	3:34
60	40			Flash			Flash	
55	45			Flash			Flash	
50	50			Flash			Flash	
45	55			Flash			Flash	
40	60			Flash			Flash	
33	67	23.0				:03	:05	:04
25	75	23.0	:02	:07	:05	:08	:09	:09
20	80	22.8	:05	:04	:05	:09	:07	:08
15	85	22.4	:19	:17	:18	:27	:26	:27
10	90	22.4	2:30	1:50	2:10	4:05	3:30	3:48
0	100	22.8	4:10	4:45	4:27	6:10	6:15	6:13

The most interesting property demonstrated by these tests is the very high strength attained by aluminate cement at 24 hours, the strength being greater than that of portland cement at 28 days. Maximum strength seems to be reached at from three to five days. The strength of the best 1:2:4 aluminate cement concrete at 5 days was almost exactly twice as great as the strength of the best 1:2:4 portland cement concrete at 29 days.

It is frequently stated that aluminate cement requires more water than portland cement, but the results of these tests are not in accord with that statement. The strength of the aluminate concrete was, in practically all cases, inversely proportional to the amount of water used. When the strengths are plotted, the curves representing the various slumps are approximately parallel lines, the greatest strength occurring with the use of the smallest amount of water. It took practically the same amount of water to produce a given slump with aluminate cement as with portland cement.

When the strengths of the various mixes are plotted so as to show the relation between the strength and the percent of cement in the mix, the resulting curves are practically straight lines except for a break at the 1:2:3½ mix. This refers to the 24-hour strength only, as the investigation has not included sufficient tests, as yet, for the determination of these relationships at later periods. At 29 days a 1:4:8 aluminate cement concrete has about the same strength as a 1:3:6 portland cement concrete, while 1:3:6 aluminate is about as strong as 1:2:4 portland.

Absence of moisture during the curing period seems to have much less effect on aluminate cement than upon portland cement. In fact, in almost every case the cylinders cured in dry air were stronger than those cured in moist air, the average difference in strength being 7%.

In nearly all cases where the unit crushing strength was more than 4000 lbs. the aggregate was fractured.

An important question when aluminate cement concrete is used in connection with portland cement concrete is the strength of the bond between the two materials. Six half-briquettes of portland cement mortar were replaced in the molds and the rest of the space filled with aluminate cement mortar. The new briquettes formed in this manner were broken at the end of 24 hours and showed bond strength of 280, 125, 325, 240, 95, and 190 lbs. per sq. in., or an average of 209 lbs. per sq. in. In one case, about half the fracture was through the old portland mortar instead of being all at the bond.

Many discussions of aluminate cement state that it cannot be mixed with portland cement without causing a flash set. Results of setting time tests made upon such mixtures are given in table IX and indicate that flash set does not occur unless the proportion of portland cement falls between 33% and 90% of the mixture.

The tentative conclusion to be drawn from this investigation is that the American aluminate cement, like the European product, is well adapted for use in highway work. While its cost (about three times that of portland cement) tends to limit its use as a general constructive material, it seems to be well adapted for repair work, and for use in situations where it is urgent that traffic delay be reduced to a minimum. It should be possible to open patches to traffic the day after they are placed, thus eliminating the inconvenience and great danger of barricades and difficulty of keeping the patches moist during curing. Apparently there would be no difficulty in obtaining a secure bond between the patch and the old pavement. Several state highway departments have constructed experimental sections of aluminate cement concrete pavement and opened them to heavy traffic the following day without serious injury.

Before final conclusions can be drawn it will be necessary to make long time strength tests, abrasion tests, modulus of rupture tests, etc., and in the meantime the opportunities for observing the behavior of this material under actual service conditions are constantly increasing.

The writer wishes to express his thanks to H. S. Spackman, P. H. Bates, Edwin C. Eckel, and to several other American and French engineers who have studied and used aluminate cement, for the valuable information and suggestions which they have given him, to M. H. McGaffigan for making the chemical analysis, and to the manufacturer for supplying the cement used in the investigation. The hearty cooperation of Professor A. H. Blanchard, the officials of the Michigan State Highway Department, and the State Highway Laboratory staff has made this investigation possible.

Building Trades Apprentices Given Diplomas

Building trade apprentices will be given diplomas showing completion of certain prescribed work in the Cleveland Building Trade Schools on Friday, April 10, 1925.

Classes in plumbing, bricklaying and carpentry have been in operation in Cleveland for a number of years, and the 150 apprentices who will receive their diplomas at the first annual commencement represent these three groups. During the early part of January, apprenticeship courses in painting and electrical work were started. At the present time there are approximately 1000 apprentices in the five trades attending the part-time schools. This form of instruction has proved so attractive that there are hundreds of boys on the waiting list who will be admitted to the schools just as soon as places are available.

The apprentice classes operate under the Smith-Hughes Law, which is a Federal Act that provides for federal aid in the support of part-time trade schools. The balance of the money required to carry on the schools is furnished by the local Board of Education. The building materials used in the schools are supplied by the local material manufacturers and dealers.

Rapid Hardening Portland Cement

The accompanying curves reproduced from *Concrete and Constructional Engineering* give the results of some tests of beams up to 28 days, the test beams being made with the new Ferrocrete rapid hardening portland cement recently put on the market in England. The general conclusions, based upon these results are as follows:

The results indicate that the new cement is a product of a very great practical importance and it will not only have special importance in cases where an early strength is required (for example, in the case of road construction, special surface finishes requiring to be subjected to wear at an early date, and places where early removal of centering and temporary supports are required, as well as where Ferro concrete piles are required to be driven at an early date) but the greatly increased strength of the material even at later dates should justify substantially greater working stresses with this new material and so make it specially useful and economical for reinforced concrete columns, beams and structures generally. It will, of course, be important to get local authorities to make provision for higher working stresses for this stronger material before full advantage of its valuable properties can be taken in many structures subject to such regulations, and this is a matter which ought to have the prompt attention of scientific bodies.

Test Specimens

Altogether 24 beams were made, 12 with ordinary cement and 12 with Ferrocrete rapid hardening portland cement. To insure identical weathering, all the beams were made on the same day under identical conditions and stored under identical conditions. The aggregates were what are known as Ham River ballast and sand and the proportions were 5½:1, but specified more accurately and the water was carefully controlled. Mixing was done by hand and ½ in. of cement mortar placed at the bottom of the mold before the concrete proper was placed. The steel was ordinary commercial mild steel conforming to British Standard Specification and to insure comparative results, all the rods were from the same rolling. The steel had a yield point of 21.3 tons per sq. in. and a breaking strength of 31.5 tons per sq. in. in the case of the 1¼ in. rods. The ⅜-in. rods had a yield point of 24.1 tons per sq. in. and a breaking strength of 31.9 tons. The beams were designed so as not to fail in shear.

Tests cubes were made from each batch of concrete used in the beams and numbered similarly, stored under identical

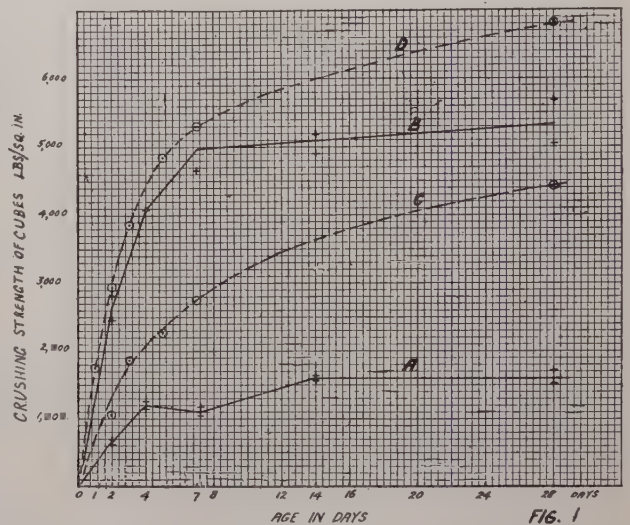


Fig. 1—Comparison of strength of rapid hardening and ordinary portland cement concrete

A=Average portland cement concrete made by contractors' workmen
B=Ferrocrete (Rapid hardening) portland cement concrete made by contractors' workmen
C=Average portland cement concrete made in laboratory
D=Ferrocrete (rapid hardening) portland cement concrete made in laboratory

conditions and tested at the same time as the beams. When the beams were due to be tested they were carted to the laboratory and to prevent risk of the upper flanges of the beams cracking during transit, this flange not being reinforced, temporary bolts ¾-in. in diameter with washer plates at the two ends of the beams were used to put the top flanges into a state of compression just sufficient to overcome any accidental tension stresses which might occur in transit. When the beams arrived at the laboratory and had been put into the testing machine these bolts were removed and returned to be used again on the next beams.

Results of Tests

The results of the tests represented in Figs. 1, 2, and 3 are given as follows:

Fig. 1 is a curve in which the crushing strength of the cubes is plotted against the age in days. Curve *A*, being the strength for the ordinary concrete cubes prepared by the contractor, gives a strength in 4 days of about 1200 lbs. per sq. in. increasing in 28 days to about 1600 lbs. per sq. in. There are the variations which are commonly found in curves of this kind, and the results are, of course, lower than the corrsponding laboratory tests for the same materials and the same cement. This is only what we should expect.

As a comparison to curve *A*, curve *B* gives the results of the concrete made with Ferrocrete rapid hardening portland cement, also by the contractor's workmen. It will be seen that at 4 days the results are approximately 4100 lbs. per sq. in. increasing to about 5350 lbs. at 28 days. In other words, at 4 days the concrete is over 3½ times as strong, and at 28 days it is over 3¼ times as strong. On the same figure are given two other curves, *C* being the test cubes on ordinary cement from the same works prepared by Messrs. Riley, Harbord & Law, made under laboratory conditions and kept at standard temperatures for the whole length of their maturing. Curve *D* shows the strength of similar cubes made by the same firm of testers, but of the same rapid hardening portland cement as was used for the test beams. It will be seen that Messrs. Riley, Harbord & Law's tests, which are shown dotted on the figure, are in both cases higher than those made by the practical workmen of the contractor, and this is only to be expected. The difference is particularly marked in the period between 14 and 28 days and is largely due to the fact that the test beams and the corresponding cubes made by the contractor were taken out into the cold December weather when they were 14 days old, whereas the cubes made by the testing firm were kept under standard temperature conditions to the end. There is no doubt that had the test specimens been kept in a moist damp temperature for the whole period they would have shown a much bigger increase in strength and the curves *A* and *B* on Fig. 1 would have approximated more closely to curves *C* and *D* respectively.

The curves in Fig. 2 would also have shown a greater rate of growth as it is well known that concrete grows very little in strength at the low temperatures in cold winter weather. Fig. 2 gives the corresponding results but those of the test beams instead of the cubes. Curve *A* is the load causing fracture on the beams made with ordinary concrete and curve *B* the breaking load on the beams made with rapid hardening cement. It will be seen that at 4 days the ordinary concrete beams carried about 6500 lbs. and at 28 days about 12,200 lbs. The corresponding figures for the rapid hardening concrete are 19,000 lbs. at 4 days and 24,750 lbs. at 28 days. The beams made of the rapid

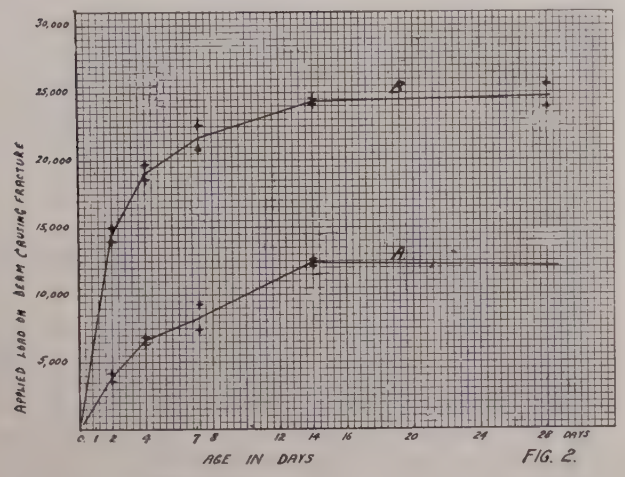


Fig. 2—Comparison of strength of rapid hardening and ordinary portland cement concrete

A=Average portland cement concrete
B=Ferrocrete (rapid hardening) portland cement concrete

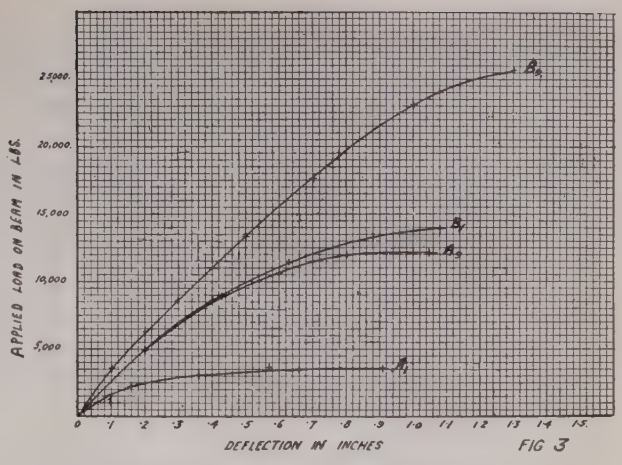


Fig. 3—Comparison of strength of rapid hardening and ordinary portland cement

A¹=Beams of ordinary concrete 2 days old
A⁹=Beams of ordinary concrete 28 days old
B¹=Beams of Ferrocrete (rapid hardening) portland cement 2 days old
B⁹=Beams of Ferrocrete (rapid hardening) portland cement 28 days old

hardening cement are therefore approximately 3 times as strong as the other at 4 days and approximately twice as strong at 28 days.

It is to be specially noted that the curves do not indicate any reduction in strength, even relatively, and rather indicate that this ratio of strength of twice would be maintained at greater ages.

Fig. 3 is a curve showing the relationship between the applied load and the deflection of the beam in inches. To avoid confusion only four curves are shown on this diagram, *A1* and *A9* being beams of ordinary concrete tested at the age of 2 days and 28 days respectively and *B1* and *B9* being the results of test beams made with the rapid hardening cement tested at the age of 2 days and 28 days respectively. It will be seen that in all cases a deflection of somewhere just over 1 in. is reached at fracture, independently, or almost so, of whether the beams carried a load of about 3500 lbs. as in the case of *A1* or 25,600 lbs. as in the case of *B9*. In other words, the new cement not only carries a far greater stress than the ordinary concrete, but carries this increased load at practically no increase of deflection. This means that its modulus of elasticity is increased roughly in proportion to its increased strength; to the practical man it means that a beam made with Ferrocrete rapid hardening portland cement will carry two or three times the load of a beam made with the ordinary cement without an increase in deflection which for some purposes is quite an important consideration. The result is an especially interesting one and bears on the regulation in the London County Council regulations for reinforced concrete under the 1909 Act, in which the modulus of elasticity is made to depend on the crushing strength of the concrete, a theory which is strikingly borne out by these tests, whether that increase of strength is obtained by the increasing age of the specimen or whether it is obtained by the use of the superior cement.

H. F. Janda, Assistant Director, Highway Research Board

Announcement is made by Charles M. Upham, director of the Highway Research Board of the National Research Council, of the appointment of H. F. Janda as assistant director. Mr. Janda is a graduate of the University of Wisconsin, and for two years was assistant city engineer at Portage, Wisc. He was instructor and assistant professor of Civil Engineering at the University of Cincinnati for five years. As associate professor of Highway Engineering at the University of North Carolina for three years he was in charge of experimental research in cooperation with the State Highway Commission. Mr. Janda has carried on many important research projects, including capillary moisture in highway subgrades, earth pressure tests on culvert pipe and other problems affecting highway construction.

Mr. Janda is located in the offices of the Highway Research Board in the Building of the National Academy of Sciences and National Research Council at B and 21st Streets, Washington, D. C.

Design, Construction and Maintenance of Reinforced Concrete Pavements

By H. Eltinge Breed
CONSULTING ENGINEER, NEW YORK CITY

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More than a decade ago it became apparent to many road builders that the smooth, hard-surfaced, rigid type of pavement would best meet the demands of the bewilderingly increasing traffic upon our roads. We advocated in locations where the cost would be justified, the building of concrete roads. In many cases, through the years since, these roads have been entirely satisfactory from the standpoint of both engineer and public. But in some cases they have not. Trouble has started, ranging from small cracks to disintegration of the slab. We sought the causes, which were almost as many, superficially, as the failures themselves. Gradually through search, research and experience, they resolved themselves into a comprehensive fundamental. Meanwhile we had learned considerable about building concrete roads, and realized how important to success was every step in the process, from selection of aggregates to final curing. Not only did we want some safeguard, (as much as we could afford) against possible errors of judgment or execution on the work, we wanted even more some remedy for the fundamental cause of the trouble, to which all other causes were only contributing factors. In short, we wanted something to offset the indefinite and indeterminate stresses set up in the green concrete, and continued through the life of the pavement by every change in weather, by every change in temperature from night to day, by every volume change in subgrade, by every pounding vehicle. We went to structural design for our idea, and came away with steel reinforcement.

Anything that tends to promote stress or be of low resistance to it, is a source of weakness in the pavement. Most important of these are:

1. Faulty materials
2. Improper proportioning
3. Low density
4. Poor mixing and working
5. Too much water
6. Disregard of temperature conditions
7. Inadequate curing
8. High porosity permeability and absorption.

1. *Faulty Materials.* No structure is stronger than its weakest part. Then both aggregates should be stronger than the cement which binds the mass together in order to insure developing the full strength of the cement. Stone which is hard and durable is dependable; but rock of high absorptive value, or unstable rock such as the Arenacious shales and Feldspathic sandstones has led to early disintegration of the concrete. Sands, many of which are adequate for masonry mortar construction, have proved so unsatisfactory in concrete work that through the efforts of various research and test agencies most specifications provide for proper control such as grading, freedom from silt and organic matter etc. (See footnote 1 at end.)

2. *Improper Proportioning.* Usually the method of proportioning is arbitrary such as 1:2:3, 1:2:4. The strength of cement and the large amount of properly graded aggregates has caused this method to suffice in mass concrete, and concrete protected from the weather, but it is bad for road work. Proportioning by void determinations is likewise unreliable because of the varying void content of the aggregates under different moisture conditions. Proportioning by mechanical analysis gives good results but in more uniform shipments of materials requires laborious checking and readjustment to keep proper control. Proportioning by fineness modulus and proportioning by maximum density tests are two other methods both of which give good results.

3. *Low Density.* Low density comes from improper proportions, entrained air and excess water voids. The greater the density, other things being equal, the stronger the concrete.

4. *Poor Mixing and Working.* Poor mixing and working results usually from too much hurry. A full minute of time in the mixer is absolutely essentail for each batch, and additional time will give increased strength. The working of the concrete is to exclude air and consolidate the mass.

5. *Too Much Water.* Too much water gives low strength (see footnote 2 and 3 at end) and a highly porous concrete. Uncombined water in excess of the amount required to hydrate the cement, leaves voids in the set concrete which are potential sources of trouble.

6. *Disregard of Temperature Conditions.* Temperature conditions at time of mixing and laying concrete are important. Concrete mixed at an average temperature of 50° F. is only 82% as strong as the same concrete mixed at an average of 70° F. (See footnote 4 at end).

7. *Inadequate Curing.* The influence of methods of curing is such that as much water as it is possible to get on will benefit the pavement by accelerating chemical action and preventing too rapid drying out.

8. *High Porosity Permeability and Absorption.* Resistance to action of water and moisture is dependent on the porosity, permeability, and absorptive quality of the concrete and the expansion and contraction of the mass. Dr. Hatt (footnote 5) in his conclusions to a research study on "The Moisture Effect on Concrete (footnote 6) says:

"The strength of concrete, like that of wood, varies with its moisture content. While the law relating to moisture content and to strength was not determined throughout various ranges of moisture content, it appears that saturated concrete will have 80 to 85% the strength of dry concrete."

This was confirmed in a research project I carried out for the Borough of Queens, New York city on cubes cut from one of their pavements, which gave values wherein wet cubes averaged only 75% of the value of dry cubes. Further confirmation is the work of H. S. Mattimore, Pennsylvania State Highway Department and G. S. Hutchinson, North Carolina Highway Department. Dr. Hatt further says:

Concrete expands when immersed in water and contracts on drying. The degree of change of length varies with the characteristics of the brand of cement, with the richness of the mix, and with the size of specimen, and with the conditions of exposure. Measurements begun after the initial hardening of the cement show that concrete may expand 0.01% due to the absorption of moisture, and may contract 0.06% when exposed to dry air. These changes continue. To these values should be added the changes in length during the initial setting of the cement. * * To be durable, concrete structures should be designed for the least favorable conditions. Stresses arising from the effect of temperature and moisture as well as those due to dead and live loads should be considered.

Further characteristics of the relation of heat and moisture to concrete are the thermal coefficient of expansion (footnote 5), the warping effect, (footnotes 5, 6 and 7) and shrinkage from drying (footnotes 5 and 6). Says Dr. Hatt:

Without careful curing, concrete masses will undergo excessive surface shrinkage against their rigid cores, thereby favoring surface cracks. Therefore steel reinforcing should be placed near enough to the surface to withstand these shrinkage strains, and at the same time far enough below the surface to be protected against corrosion.

Dr. Hatt's beliefs about requirements "for concrete structures exposed to the weather," are as follows:

(a) A portland cement of normal volume constancy and a clean, well graded aggregate.
(b) An impervious concrete of proportions not less than 1:2:4.
(c) A time of mixing of not less than 1 minute and preferably 1½ minutes for the production of uniform concrete.

(d) A concrete mixed with a minimum amount of water appropriate to the work at hand.

(e) Careful slicing of this dry concrete against the face of the forms so that the reinforcing steel may not be exposed nor the surface require patching.

(f) Early curing begun just after the initial set and continued for a time depending on local conditions.

(g) Design of reinforcing steel and contraction or expansion joints to prevent cracking and the entrance of water.

These eight common sources of trouble all operate either to promote stresses or to lower the resistance of the pavement to stresses. Our aim has been in every way to eliminate or correct them as far as we could along the lines I have just roughly outlined, and at the same time to give to the pavement additional resistance to stresses. The general tendency has been toward the use of steel as a method of reinforcement. But there have been and are wide differences of opinion about the amount of steel it is economical to use to get best results at least cost, and about the best distribution of the steel throughout the pavement. It is the main purpose of this paper on "Design and Construction and Maintenance of Reinforced Concrete Roads," to present some tentative conclusions about these problems drawn from recent experiments and experience.

Experiments have been made at Arlington, Va., on concrete slabs over wet and dry sub-grade conditions under impact and static load tests. These are some of the conclusions regarding the steel thus far reached and reported by A. T. Goldbeck, Chief, Division of Tests, U. S. Bureau of Public Roads.

Reinforcing steel in concrete slabs, if present in sufficient amount and so placed as to receive tensile stress, adds to the resistance of the slab to impact.

Reinforcing steel placed longitudinally and transversely in equal percentages is more effective in preventing corner failures than the same amount placed in one direction.

For a given percentage of steel, small deformed rods closely spaced seem to be more effective than large deformed rods widely spaced.

In some of the tests there was evidence that while the presence of the steel did not assist greatly in preventing the formation of the first crack it did prevent the development of the crack and the further failure of the slab.

The portions of slab left unharmed have subsequently been tested under static load, both at the corners and along the edges with the following results: The presence of mesh reinforcement as employed in the slabs under consideration, does not increase the load-carrying capacity of concrete slabs but does give rise to a tendency to hold together and resist complete failure after initial or elastic failure has taken place.

Other indications from observations of the Columbia Pike investigations (footnote 7) are:

The Columbia Pike investigations have been described in the October 1924, issue of *Public Roads*. Briefly the road consisted of 32 sections of both plain and reinforced concrete. The variations in the sections consisted of changes in thickness, changes in cross-section design, the use of cinders under some of the sections and the use of various percentages of reinforcing steel.

Careful observations were made of the development of cracking in the sections and subgrade samples were taken from time to time to note the moisture content and also physical characteristics of materials under various sections of the road. "That longitudinal steel up to a certain amount does increase the spacing of transverse cracks and these cracks will open on contraction." "That longitudinal steel above this amount might produce fine transverse cracks, spaced in some cases only a few feet apart." These are Mr. Goldbeck's statements.

Look for a moment at Arlington tests on slabs reported by L. W. Teller in the journal of *Public Roads*. All 4-in. plain slabs on wet subgrade were in such condition that they could not be tested for impact. Numbers 230 and 231 were too badly broken to test and 240 and 241 withstood only static load. On the other hand slab numbers 250 to 259, 4 in. on wet subgrade, reinforced with from .21 to .32% of steel, resisted impact pressures from 7025 lbs., 8300 on the edge and 7790 lbs. to 10,950 lbs on the corner. A fact to be noted is that the slab with .21% of steel gives resistance values to impact as high as that slab having .82% of steel. This holds also in the tests made on 6-in. reinforced slabs on a wet subgrade.

I have checked many of these observations by actual service conditions. A case in point is the pavement at Brightwaters, New York, built in 1921 of 5-in. plain and reinforced concrete, 16 ft. wide, 1:2:3 mix. There are two reinforced sections: One is a divided slab with 45 lbs. of mesh per 100 sq. ft. on soft fill over tide marsh of quaky character; the other is 16 ft., full width, on sand and sand and clay, part of it filled ground. The joints are 50 to 60 ft. The following is the result of a crack survey:

	No. of Slabs	Corner Breaks	No. of Slabs Cracks	Total No. Lin. Ft.	
				Transverse	Longitudinal
Half width reinforced section on soft subgrade.....	77	2	28	463	0
Half width reinforced section of fair subgrade.....	36	0	7	149	0
Full section on plain sand subgrade.....	64	7	45	817	1105

Here it is evident that the divided slab eliminated all longitudinal cracking. The plain concrete had .25 ft. of transverse cracks per lin. ft. of road while the reinforced had only .1 ft. The plain section had 12 corner breaks per mile while the reinforced section had 2.

Section 51 of the Bates Test Highway, Illinois, after destructive tests is still doing fine service in good condition. This is a 6-in. uniform section, reinforced with 45 lbs. of mesh per 100 sq. ft. and had there been a buffer section between that and a weak sister it would be intact today.

I have previously reported many miles of similar conditions. There is no question in my mind but in the light of all the evidence:

A. Reinforcing steel helps whether in full or half width work to resist early stresses at a critical strength period from the first day to the twenty-eighth day, and then acts to help preserve the integrity of the slab.

B. That it reduces materially longitudinal cracks when used in full width work.

C. That when used in proper amounts the slab lengths can be extended to 50 ft. and upwards to 100 ft.

D. That except additional amounts at corners and along the edges, any amount of steel used above that necessary for temperature stresses serves no useful purpose until enough is used to reinforce as a full structure. The cost of such complete reinforcement for highways is unnecessary and prohibitive.

E. Steel is essential to preserve the integrity of the slab in the first 28 days of the pavement life, for when cement and aggregates are mixed with water, chemical changes begin which convert the plastic mass into a material whose strength in tension and compression increase with age. Evidence of these changes is the hardening or "set" of the concrete, which occurs within 24 hours after the mix is laid. Its tensile strength or ability to withstand pulling apart, practically nil on the first day, increases at a varying rate daily, until at the end of 28 days it is 90% of the strength it will have at two years. At 3 days, it has 34 lbs. tensile strength per sq. in.; at 7 days, 61 lbs.; at 10 days, 81 lbs.; at 14 days, 95 lbs.; and at 21 days, 109 lbs. These figures represent minimum values found in the laboratory. As field values would run even lower, the ones quoted are those on which we must calculate in order to secure a reasonable margin of safety.*

Compressive strengths for 1:2:4 or 2000 lbs. concrete ar 28 days for early ages are as follows:

Days	(1) Compressive Strength—Av. Temp. of 68° F.	(2) Compressive Strength—Av. Temp. of 71.2° F.	(3) % of 28-Day Strength		(4) Tensile Strength for Col. (1)
3	400	500	30%	600	34
7	720	700	46	920	61
10	950	800	57	1140	81
14	1120	1020	70	1400	95
21	1280	1240	82	1640	109
28	1350	1400	100	2000	114

*A. T. Goldbeck, U. S. Department of Agriculture Bulletin No. 532—The Expansion and Contraction of Concrete Roards—Page 6.

Col. (1) (2) (3) from A. B. McDaniel, on "Effect of Temperature on Concrete," *Proceedings* American Concrete Institute, 1916, pages 245, 248, 259, and 260.

Col. (4) computed by taking 8½% of the values given in column (1) Johnson's *Material of Construction*, page 419, on relation of tensile to compressive strength. The above values, though appearing low, are not exceptions and are confirmed by many investigators.

But the changes in the drying out of concrete during the increase of its tensile strength, set up also the destructive stresses. These are due to expansion and contraction. As the moisture is evaporated from concrete, its bulk thereby diminishes, and the mass contracts. In general, the tendency is to shorten its length.* The pull comes between different sections of the mass. If on the other hand, due to different conditions, expansion occurs, you have first push and then pull. If the resistance can be fostered to withstand this pull, the pavement holds its integrity. If it cannot, the sections yield to the pull and separate, leaving cracks between them which subsequently widen. It is these cracks, which, requiring maintenance, menace the life of the pavement by multiplying the places of weak resistance to impact. Devices have been tried to substitute moisture to replace that evaporated and so give the concrete a chance to establish some srength before meeting severe stresses, but none of these—wet burlap sprinkling or straw or earth covering, has been wholly satisfactory, though they have helped. The difficulty is that the moisture cannot be supplied to the pavement as fast as it is evaporated, or at the same uniform rate; also, when the pavement is sprinkled, some of the water is bound to run off to the edge of the pavement, where it causes volume changes and sets up other stresses.

The problem is then to increase the resistance of the concrete to tensile stresses at a time when those stresses are strongest and the concrete itself is weakest to withstand them. The only way we now know to do this is through the use of reinforcing steel. The steel fabric with its welds has its full strength when it goes in to the wet slab. Used in proper quantities, that strength is sufficient to preserve the integrity of the concrete slab against the opening up of any cracks that form.†

Other factors of design are generally agreed upon.

The thickened edge and balanced design (i. e. strength in the center of the slab equal to 7/10 of the thickened edge) are approved by Mr. Older, Mr. Goldbeck and general service conditions.

The tongue and groove longitudinal joint transfers the load across the joint to the other slab, as is shown in the deformations on the Harrisburg Test Road, which indicate that ⅓ or more of the load is transferred.

Other principles of design generally accepted in theory and used in construction are:

The use of dowels across both transverse and longitudinal joints to transfer the load.

The use of the design formula recommended by Mr. Older and since adopted in the Association of State Highway Officials' Specifications and American Society of Municipal Improvements tentative specification for concrete pavements.

$$T = \sqrt{\frac{3W}{S}}$$

where T equals edge thickness
W equals maximum wheel load
S equals allowable working tensile strength in concrete which should not exceed 50% of the modulus of rupture.

The use of a waterproof joint material. This can be secured by a poured asphalt mastic joint material.

The use of additional reinforcement along the center joint and the edge of the pavement.

In regard to maintenance direct comparisons between reinforced concrete and other types of pavement are difficult to obtain. Figures of the cost of maintenance for the State of Ohio for the year 1922 for 4,700,000 sq. yds. of plain concrete roads there was a cost of $0.0223 c per sq. yd. for maintenance while for 2,900,000 sq. yds. of reinforced concrete pavement (light mesh or circumferential reinforcement), the cost of maintenance was $0.0043 per sq. yd. or only 1/5 of the cost of maintaining the plain concrete pavement.

This relation is approximated in the work in New York State, and in my experience with my own work.

My conclusion is that with reasonable first cost and negligible maintenance we can, safeguarding the eight common sources of trouble in concrete pavements, reinforce the carefully built pavement with steel, and we can thereby get a result that will bear whatever traffic may legitimately be put upon it, uninterruptedly, 365 days a year. By reasonable first cost, I mean a capital investment in a road that through actual social and economic service rendered will pay its interest charge and amortize itself during the life of the pavement. By legitimate traffic I mean traffic in accordance with the best laws now enacted in regard to speed, maximum loads, and relation of load to width of tire.

A Bibliography of the Works Consulted and Opinions Quoted

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2. Professor Duff A. Abrams, Bulletin, Structural Materials Research Laboratory, Lewis Institute, Chicago, Illinois.
3. Professor A. W. Talbot, Bulletin 137, Engineering Experiment Station, University of Illinois, Urbana, Ill.
4. Professor A. B. McDaniel, *Proceedings*, American Concrete Institute, 1916.
5. Dr. W. K. Hatt, *Proceedings*, American Society of Civil Engineers, 1925.
6. Clifford Older, Bates Experimental Highway, Illinois.
7. A. T. Goldbeck, Chief Division of Tests, U. S. Bureau of Public Roads, Journal, *Public Roads* 1925.

†A. T. Goldbeck, U. S. Department of Agriculture—Bulletin No. 532—"The Expansion and Contraction of Concrete Roads" pages 10 and 11 shows the beneficial effect of steel to minimize expansion and contraction. Also page 30, par. 8, "Reinforcement decreases, but does not prevent, the shrinkage and expansion of concrete due to drying and has no effect on temperature changes. Reinforcement can not, therefore, entirely prevent cracks, but seems to distribute them and keep them small."

Special Cements

Instead of one standard and one quality of cement which in this country has become generally understood to mean portland cement, concrete designers and cement consumers now have at their disposal several special cements developed to meet the particular requirements of certain classes of work. Recent additions to the cement repertoire are Atlas Lumnite, Monolith Plastic Waterproof portland cement and Peerless Super Cement.

Lumnite cement is a high alumina cement similar to the "ciment fondu" which has been in use in France for several years and which first came into general notice in connection with wartime construction where a quick hardening cement was required. Further observations regarding the use of the American product, Lumnite, which has been put on the market in this country during the past year by the Atlas Lumnite Cement Co., New York City, are given elsewhere in this issue.

Monolith Plastic Waterproof portland cement made by the Monolith Portland Cement Co., Los Angeles, Calif., is a portland cement to which addition has been made of a water repellent material.

The latest addition to the list of special cements is Peerless Super Cement made by the Peerless Portland Cement Co., Detroit and Union City, Mich. Super Cement, the properties and uses of which have been outlined previously in Concrete is the discovery of an English investigator. It was used in Great Britain for a number of years before it was introduced in Canada in 1920. The Peerless company has now secured the rights to manufacture Super Cement and is prepared to furnish its customers with the new product.

Super Cement was employed by the British Government during the late war in much of its construction work including the construction of petrol or gasoline reservoirs. It is described as a more efficient form of portland cement rendered so by the incorporation of a substance known as "Catacoll" during the manufacturing process. Catacoll itself has no particulat cementing value. It replaces a part of the gypsum ordinarily used in portland cement manufacture, and is not water repellent. Its function is to facilitate the reaction which occurs between the mixing water and the constituents of the clinker.

It is claimed that Super Cement hydrates more thoroughly than portland cement, a greater portion of it combining chemically with the mixing water to form the cementing medium on which concrete depends for its qualities of cohesive and adhesive strength and stable density. It is further claimed that this special product is more efficient as a lubricant to the mix, minimizing the tendency toward segregation in handling concrete into place.

Hollow Concrete Walls by Phillips System

Fig. 1—The Raymond Apartment, San Diego, California, built by the Phillips monolithic method. The walls were put up in about 6 days

The Phillips system of reinforced concrete construction, which has been used on about $200,000 worth of work in California in the last year, employs concrete columns or studs and a thin, outer reinforced concrete slab, all cast at one operation.

For one and two-story work, the outer part of the wall is 2 in. thick and this slab is enlarged to form studs 16 in. o. c. The depth of this stud is 4 in. Wooden wedge shaped inserts are put into the concrete on the inside face of the vertical stud to which nailing strips may be attached.

One $^{8}/_{8}$-in. deformed bar is put in each stud while ¼-in. bars spaced every 12 in. of height reinforce the slab.

Figs. 2, 3, and 4—Construction views showing different stages of the work

Pan shaped forms produced the spaces between studs and the stud space closed between pans by an upright board. Shiplap is used for outside forms without cutting and is reused to sheath the roof.

Window and door frames are set to form a recess and to allow the concrete to seal them in as it is poured into place. Air inlets are provided over each vent to the foundation so that air circulates freely throughout the walls.

When the foundation is built monolithically with the remainder of the structure, the center foundation walls and piers are put in and the floor joists placed and extended about 4 in. over the inner form boards to rest on the concrete. Sub flooring is laid and in every case, all partitions are set and ceiling joists placed. The forms are built up and staked in place for the inner side of the wall, and only the posts outside are set up.

The joists are carried on the edge of a 1 x 6 in. piece which

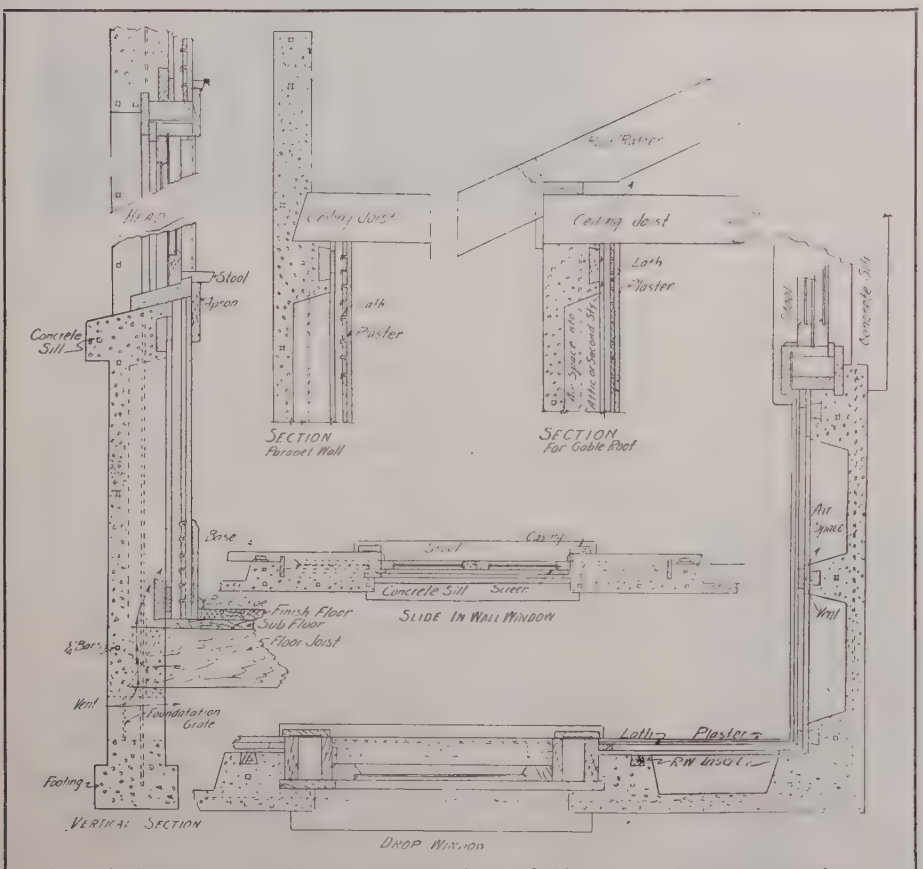


Fig. 5—Details of the Phillips method of monolithic concrete house construction

has been run all around the outer walls and set to form the inside form for the concrete, there being a solid fill at this point. The 1x6-in. piece is spaced off on the lower edge and 1x6-in. pieces set in each stud face, 16 in. on centers. These pieces are cut 8 ft. long where the ceiling height is 8 ft. 6 in. and can later be used on the roof without waste. Short length forms for different length windows are carried in stock.

Uprights made of the roof timbers, usually 2x6's are set all around the house, about 3 ft. apart and cleated to the form at the top. Two or three 1x6's are slipped in and the upright steel put into the hollow space in each stud. A runway is built around the building and the concrete brought in wheelbarrows and dumped into a shallow box, then put into the walls in successive layers about 12 in. high. The horizontal steel is laid in as the wall is built up. Carpenters follow the placing of the concrete and more boards are placed, the work going around the building. Usually the time is from one to two days to run the walls for the first story—280 linear feet of one story wall has been built by this system in 2 days. The form boards are put up wet, and kept wet while on the walls. They may be taken down after one day if the concrete is kept properly sprinkled until it is cured.

A mix of 1 cement, 2½ sand and 4 parts gravel has proved satisfactory and will produce an outside texture that will hold the stucco. Window sills are cast in after the forms are taken down. The plumber and electrician can work without any inconvenience and the furring strips can be found on the 16-in. centers if the usual care has been taken in setting the forms.

The walls are being contracted for at about 35c per sq. ft. of surface from the top of the foundation to the inside parapet walls, which are usually run about 4 in. thick and 30 to 36 in. high. The furring strips are furnished and put on and the window and door frames set, all included at this price.

The Phillips monolithic construction is being worked out in cooperation with Hurlburt & Tiful, the general contractors, the wall construction being done as a subcontract. Common labor is used chiefly.

Wood and Wire Forms for Grouted Walls

The accompanying illustration shows the peculiar construction of the Henri Hicks houses. The walls may vary in thickness with the perpendicular studding used. These studs may be 1x2's, 2x2's, 1x3's, 2x3's, 1x4's, or 2x4's. The heavy wire netting is stretched and attached to the studs, forming a casing into which the crushed granite and grout are poured.

When the mixture has hardened the interior is lined with heavy paper and lath for plastering, as in other construction, while two coats of smooth cement mortar are used upon the exterior, the last coat bearing the color wanted.

The result is a wall that tests have shown to be of great stability. Besides being fire-proof, earthquake-proof and wind-resistant, it is claimed for this type of construction that it absorbs no moisture and is relatively sound-proof.

The roofs of the newer houses being built under these patents have slabs of copper welded together to form a solid sheet and this covered with two inches of green terrazzo concrete, the latter as a protection to the copper sheeting and to give coolness to the interior of the house as well as to make the open-air living room more desirable.

Houses of this type are really much less expensive than some of much flimsier material, a small one being built complete for as little as $2500. Twenty costing between $9500 and $20,000 are now under contract in a new subdivision near Los Angeles. These all have interior as well as the outer stairways leading to the roof-gardens.

Century Tile Has Triple Air Space

The Century tile is a new concrete masonry unit designed by J. Arthur Hillstrom, Los Angeles, Calif. The units are 15⅝ x 5⅝ x 8 in. made successfully on a Multiplex press machine and an Anchor stripper.

The Century unit has a triple series of air spaces.

The units weigh 32 lbs. each and the producer says that at three weeks they withstood a net crushing test of 2500 lbs. per sq. in., or 1,400 lbs. per sq. in. of gross area.

The units are being used successfully in buildings such as those illustrated.

Judgment Given Straub in Old Cinder Block Suit

Judgment has been entered by the United States District Court for Western Pennsylvania in the suit brought by F. J. Straub against H. P. Campbell. The suit was based on Straub's U. S. cinder block patent No. 1,212,840, and in 1919 a decision was obtained[1] enjoining infringement. Proceedings were later instituted to have the damages suffered by Mr. Straub assessed and these have now been fixed at $18,750.

[1]See CONCRETE June, 1924.

Rock-Boring Mollusks in Concrete

That the boring action of the rock boring mollusks which were found in 1922 and 1923 in old concrete cast around wooden piles in Los Angeles harbor is accomplished by chemical rather than by mechanical means is the conclusion of W. R. Sadler, chief chemist, Los Angeles Harbor Dept., and D. E. Hughes, civil engineer, San Pedro, Calif., based upon tests and observations outlined in *Engineering News-Record*. The authors believe, in view of their observations, a good concrete containing everywhere an aggregate of gravel or of broken stone differing in kind from that on the beach, together with any sand or else containing only silica sand, if part of it is coarse, will be immune from the attack of borers in Los Angeles Harbor.

The observations were carried on with concrete jackets cast around wooden piles some 16 years ago and it was found that the concrete attacked consisted of 1 part of cement to 3 parts of sea sand or a richer mixture. It was found that the jackets that tested high in compressive strength had from 1 to 5 borers per sq. ft. while concrete of a lower test strength had from 4 to 10 per sq. ft.

The concrete tested was classed as a fairly good concrete and the entries of the borers were holes no larger than pin heads, and in many instances much smaller. The point of attack seemed to be between the mud line and 20 in. above that line, and in no case were the bore holes found higher than 4 ft. above mean tide. It was also found that the concrete having coarse aggregate, either broken stone or gravel that was foreign to the immediate locality was not attacked.

Investigations showed that along the beach either live Pholas or perforations made by them were found in every variety of rock that is native to the locality, including sandstones of every degree of coarseness and hardness, limestone, shale, indurated clays and other stones of which some are hard enough to scaratch window glass. It is found that no attacks had been made on any material other than neat cement brought to Los Angeles from a distance.

Examination of the mollusks showed that the shell is laminated and rough and of such nature as to indicate very little if any rotary motion. The shells were also softer than some of the stones penetrated. The heads were not symetrical and in many cases, the forward end of the shell was not yet formed and the organic part extended considerably in advance of the shell.

The material immediately surrounding the hole, both in the concrete and in the rock attacked was altered in appearance to a depth ranging from $\frac{1}{32}$ to $\frac{1}{8}$ in. These observations led to the abandoning of the theory that action is purely mechanical.

Sections of the material containing live borers were carefully removed from their native locality and placed in containers of sea water where they could continue their normal function both on concrete and without the concrete. Checks were run on the solutions to allow the noting of any changes which might occur. These checks indicated a material increase of carbonic acid in the solutions. This carbonic acid which was the only chemically active secretion which the investigators were able to isolate is a well-known solvent for a great many classes of material and although the action is very slow, it would be rapid enough to meet all the needs of the borer in its normal state.

Recent literature of the Associated Metal Lath Manufacturers stresses the importance of metal lath in preventing damage in earth quakes—the announcement being occasioned by the light shocks of February.

Weatherproofing of Gypsum Block

Gypsum, though satisfactory as a plaster and tile for interior work, has not proved satisfactory for exterior construction, the reason being its slight solubility in water. The present use of gypsum block is therefore mainly in the construction of partitions in the interior of buildings. If this material could be so improved as to be more resistant to the weather there would immediately be opened a new market for gypsum block which has not as yet been touched. It is probable that if a method is found whereby gypsum block can be weatherproofed, the procedure may easily be modified so as to include such other products of gypsum as stucco, mortar, etc. With this in mind an investigation of methods of weatherproofing gypsum has been undertaken by the Bureau of Standards from whose technologic bulletins this information comes.

In attacking this problem three general methods presented themselves. First, covering the set material with some waterproof coating in order to keep the moisture from the gypsum; second, precipitating on the surface an insoluble compound formed by a reaction of some material with the gypsum; and third, by the addition of an integral waterproofing compound to the gypsum, which when the gypsum has set acts as a water repellent. In the beginning of the investigation many small cylindrical specimens of gypsum were made and treated in one of the ways described above, and then exposed to the weather. At definite intervals of time these were dried, weighed, and tested for absorption. At the end of one year's exposure, panels were made of the same composition as the small cylinders, which upon examination gave promise of satisfactorily withstanding the weather. These panels were exposed to the weather, and are now examined from time to time.

The first method, that of covering the set material with a waterproof coating, has so far given very promising results. Waterproof paints, varnishes, shellacs, whitewashes, paraffins, waxes, stearic acid, etc., have been used. The paints, varnishes, shellacs, and whitewashes were not satisfactory, but with paraffin, waxes, and stearic acid very good results were obtained.

However, the second method, that of precipitating on the surface an insoluble compound formed by the reaction of some material with the gypsum, has so far proved the most successful. Cylinders of neat gypsum and 1:1 sanded gypsum were made, and when approximately dry were immersed in solutions of barium choloride, sodium carbonate, ammonium phosphate, ammonium oxalate, lead acetate, and barium hydroxide. The results obtained with all of the salt solutions did not warrant the recommendation of any of them as weatherproofing materials. However, in the case of hot barium hydroxide, the results were very promising. The success of this material as a means for weatherproofing gypsum is explained by assuming that the barium hydroxide, which penetrates the pores of the gypsum, reacts with the calcium sulfate to form the more or less insoluble compound, barium sulfate. This very slightly soluble barium sulfate coating on the surface of the gypsum cylinder makes it very resistant to the weather. This protection however, is only temporary, for after a period of approximately two years exposure the cylinders begin to weather away about as fast as do the cylinders of untreated neat gypsum. After this period it is probable that another application of the barium hydroxide solution would protect the gypsum for a similar length of time. This is being investigated.

The third method, by the addition of an integral waterproofing compound to the gypsum, which when the gypsum

has set acts as a water repellent, has not given promise of good results. Among the integral waterproofing compounds used have been: zinc stearate, glue, gum tragacanth, gum arabic, glycerine, dextrin, and water glass. None of them seems to waterproof the gypsum for any length of time.

Examination of the panels and cylinders is made from time to time, and as new methods of treatment come to our attention cylinders are made and exposed for observation.

Cement and Heat Insulation

The growing development of cold storage for food has led to the scientific study of this subject from a constructional standpoint, and some valuable data upon the heat insulating properties of various materials are given in a recent report of the Department of Scientific and Industrial Research.[1] The best heat insulator is a vacuum (e. g. the vacuum flask), and still air is probably the next best. Hence the materials generally employed as heat insulators are those, such as cork, charcoal, and slag wool, having a cellular structure in which a minimum amount of solid material is combined with a maximum volume of air divided into minute spaces. From the weights per cubic foot of the insulating materials used in the tests described in the report it can be calculated that there is as little as 10% of solid material in many insulating blocks, the remainder being air in numberless voids. This being so, it is evident that the heat conducting property of the solid material itself is of minor importance compared with its property of air occlusion. For example, solid slag conducts heat readily, but slag in the fibrous form (slag wool) is an excellent heat insulator because it has 90% of voids.

Bearing these facts in mind it is to be expected that ordinary concrete (which when properly made is a dense material) has little value as a heat insulator, but it is interesting to observe that cement itself is a much better insulator than sand or stone. The flow of heat through a slab of neat cement would be only one quarter of that passing through a concrete slab, and only a tenth or even less of that passing through a slab of solid stone. Hence neat cement appears to be a suitable basis for a heat-insulating material provided it can be worked up in a manner to produce a porous block with a large proportion of voids. In this connection, particulars of various patent processes have been published which suggest that this is possible, and in course of time an important addition may be made to the industrial applications of cement.—*Concrete and Constructional Engineering.*

Lowering the Cost of Concrete

In line with the investigations which are being carried on with a view to determining how to produce a good concrete at a lower cost or a better concrete at the same cost, some tests have been carried on at the University of Washington Engineering Experiment Station and are reported in *Bulletin 31* by Ira Leonard Collier, assistant professor of Civil Engineering. The report is based upon the tests of 600 specimens.

The preface of the bulletin which follows, gives interesting facts and figures as to the actual savings that may be effected by the proper proportioning of aggregates.

By selecting the correct proportions for the aggregates, better concrete may be obtained at reduced cost in many instances. A large saving would have been possible had the Seattle Building Code permitted the engineer on a certain large reinforced concrete building to determine the proportions of sand, gravel, and cement, for the concrete that enters into the construction of the columns. The code specifies a 1:1:2 mix, and allows only 2900 lbs. per sq. in. as the crushing strength for such a mix.

This report shows that such a mix should give a strength of 4000 lbs. per sq. in. and requires 2.35 bbls. of cement per cu. yd. of concrete. To obtain a strength of 2900 lbs. a mix of 1:1.3:3.8, 6-inch slump, is necessary and requires 1.55 bbls. of cement per cu. yd. of concrete, a reduction of .8 bbls cement or a saving of $2.40 per cu. yd. of concrete. As approximately 1600 cu. yds. were used in the columns, a saving of $3800 might have been made on that one item alone.

Thermal Expansion of Stone

Determination of the thermal expansion of stone, i. e., the amount which the stone changes in dimensions with changes in temperature, has received very little attention in this country, says Bureau of Standard's News Bulletin No. 93. Furthermore, an examination of the available data on the subject will reveal the fact that the few determinations which have been made are usually based on a very limited number of observations, and are rather misleading. The values most frequently cited in text books and hand books are based on coefficients obtained by measuring the length of specimens at normal temperature. The assumption has been made that the material expands at a uniform rate at all intermediate temperatures. Determinations at the Bureau of Standards, in which frequent length measurements were made on limestone and marble specimens as the temperature was raised, indicate that these old assumptions are far from correct. For small increases in temperature above the normal the expansion is very small, and the rate increases rapidly as the temperature rises. At 100°C. the average expansion of marble is about the same as that of steel, but at 200° C. the rate is approximately doubled, while for temperatures a few degrees above the normal the expansion is only a fractional part of that of steel. These peculiarities are of particular interest where stone is used in connection with other materials, as is usually the case in modern building construction.

Marble, especially, shows other peculiarities in its behavior under temperature changes. It expands on heating but when cooled to the original temperature it does not shrink to its original dimensions, i. e., it retains a part of the expansion as a permanent growth. Specimens have been measured under low temperatures and found to expand when cooled below the normal, which is also contrary to the usual conception. Such properties are probably the cause of the peculiar instances of warping which are sometimes noted in marble headstones in cemeteries.

Tests of Sand-Lime Brick Masonry

Tests of compression strength of various masonry walls are being made at the Bureau of Standards.

"Compressive Strength of Sand-Lime Brick Walls" is a new Bureau publication by H. L. Whittemore and A. H. Stang. Eighteen sand-lime brick walls, 6 ft. long by 9 ft. high, and 18 wallettes about 18 in. long and 34 in high, of the same construction were tested in compression. Lime, cement-lime, and cement mortars were used. Half of the wall specimens were 8 in. thick and half 12½ in. thick. The sand-lime brick used correspond to the grade of medium brick according to the classification of the American Society for Testing Materials in their specification C 21-20.

The cement mortar walls were about three times, and the cement-lime mortar walls about twice as strong as the wall specimens built with lime mortar. The deformations at design stresses were 1/14 as great for the cement mortar walls and ⅛ as great for the cement-lime walls as the deformation in the lime mortar specimens. The average stress at failure was greater for the 8-in. walls than for the 12½-in. walls. The factor of safety based on the usual building code requirements was 2.4 for the lime mortar walls, 3.1 for the cement-lime mortar walls, and 3.6 for the cement mortar walls.

The ultimate compressive strengths of the walls were from 60 to 80% of the ultimate strength of the wallettes.

[1] First Report on Heat Insulators. (Special Report No. 5 by the Engineering Committee of the Food Investigation Board of the Department of Scientific and Industrial Research. Price 2*s.* net.)

A Concrete-Built Lumber City

One of the most interesting things about Longview, Wash., a small city built complete in the last two years on quiet farm valley acres as a home and headquarters of the Long-Bell Lumber Co., with its capital of 75 million dollars, is that the lumber people chose concrete as their principal construction material.

Concrete is very much in evidence there—monolithic construction; precast masonry units, ornamental features; the pavements and the sewers beneath them.

Longview was three years in the planning and two years in the building—to its present state of use and completion.

It is no accidental circumstance that concrete plays so big a part in Longview for the Long-Bell people own the products plants, managed by W. H. Sharp, in which concrete pipe and concrete masonry and ornamental units are made.

A Shope process patent license was purchased for Columbia county, Oregon, and Wahkiakum, Cowlitz, Pacific and Lewis counties, Washington and a plant built at a total investment of about $30,000, to make concrete brick as the principal product. The plant got into operation in the spring of 1923. By the end of October that year, it had made about 3,000,000 brick. The plant, with an area of 150 x 150 ft., has 8 brick machines, one block machine, one hearth tile machine. The actual plant investment is about $12,000 and built on lines similar to most Shope brick plants—a row of machines operated by hand, served into hoppers with concrete wheeled along an elevated runway above and behind the machines from a mixer at one end, the products stacked on self-racking pallets and wheeled away on rubber-tired carts to curing rooms.[1]

The number of machines in operation at any one time varies from three to ten and men employed from five to 20. Machine operators are employed on a unit production basis and laborers by the hour. The plant output is usually in busy times from 25,000 to 32,000 common brick or 12,000 to 16,000 face brick.

Essentials of the Shope patent process are described in Mr. Shope's patent (No. 985,709, Feb. 28, 1911) as follows:

* * * the block is first formed in the usual manner by mixing sand and cement in a slightly moist or semi-dry state, and pressing or tamping it in a mold. Water is next applied, as by sprinkling, to the face of the block in sufficient quantity to enter the pores or interstices of the block, and then a powder of cement, either neat or mixed with sand or other ingredients, is sifted upon the water, which is at the same time agitated so as thoroughly to saturate the face of the block. The water will thus enter the pores or voids of the block to the required depth, and carry with it the cement powder sifted thereon. The water serves both to carry the cement into the pores and to cause crystallization of the added cement, and no external pressure will be required to force the water and cement into the block. The face of the block is then stippled or otherwise treated as may be desired, and the block removed from the machine and cured in the usual manner.

It will be understood that the main portion of the block remains in a comparatively dry state so that it can be immediately removed from the mold, and all its faces, except those exposed to the water and crystallizing mixture, will be porous so that the mortar will adhere to them, while the outer face will be proof against the absorption of water because all of the interstices and pores have been filled with crystallized cement.

The word block is here used generically to include a brick, tile or other mass of any shape or size, as well as a block technically so called

Concrete was first on the ground at Longview, but that does not mean that an active sales campaign was unnecessary. On the contrary, W. H. Sharp, manager of both of the two products plants, has maintained an aggressive sales effort.

From March, 1923 to the end of that year, a total of 5,000,000 brick was sold, while the 1924 output was close to 5,000,000. The capacity of the brick plant is approximately 7,500,000 brick per year.

Fig. 1—The civic center of Longview

Fig. 2—The center of the business section

Unlike most other cities, which "just grow," the Long-Bell Lumber Co. founded Longview on a practical, workable plan, much after the graphical layout of Washington, D. C., with a zoning system separating business and residence sections.

Census figures taken in Longview in the early fall of 1924 give the population as over 5,000. Business has come into Longview, and with it, the modern city structures—most of them built of concrete brick—such as the Longview National Bank, the office building of the Long-Bell Lumber Co., the home of the realty department of the same company, the Lumbermans' Bank & Trust Co., and the community house, headquarters for the social and athletic activities of Longview. Many other buildings of an equally fine type are under construction.

In building the power house, 1,000,000 common brick as well as 300,000 face brick of Shope manufacture were used. In the city's civic center, concrete has been used in color. Colored facings as on the brick were applied to the mass concrete of this area.

Fig. 3—Interior of brick plant

[1]See description Arundel-Shope Brick Co. plant, CONCRETE March 1924, page 97.

Fig. 4—Buildings erected with concrete units

In directing the advertising and sales policies of the Longview brick and pipe plants, Mr. Sharp attributes much to direct by mail appeal. Arrangements were made to get notifications of city lot purchases, whereupon Mr. Sharp writes the purchaser a personal letter, and suggests a visit to the plant.

Beside the brick sold for business structures, thousands of brick are sold for chimneys and fireplaces, and even some interior work for homes. The strongest selling angle here is the fact that Shope brick can be faced in any desirable colors, and that to make the home as attractive as possible, the brick must match the color scheme of the interior.

If a customer wants something different from any of the samples worked out, the plant makes up the brick or tile wanted.

A Longview automobile service station asked for a bright green brick, so as to make the station visible from considerable distance, and thus of advertising value in attracting trade. The plant turned out an almost "Kelly green" to meet this demand. A large number of downtown stores are using the brick, instead of a fancy tile for front trimming, under the display windows. In the community house, 20,000 smooth face brick were used for the interior of the gymnasium.

Mr. Sharp says he is often called to do special work requiring a finish similar to the brick and tile. The plant made all of the large lamp fixtures used by the city and much garden furniture including benches, flower pots, and fountains. In all of these the units were first precast and later the facing applied.

For mutual benefit, the manufacturers of Longview and those of Kelso (the city on the opposite side of the Cowlitz river) have formed what is known as the Inter-City Manufacturers Association. At present, there are 47 members, comprising not only the larger manufacturers, but owners of bakeries and candy factories. The four newspapers supported by the two cities are all active members. The main purpose of the organization is to encourage and promote the sale of home manufactured products, thereby increasing our payrolls. The Manufacturers Association is a branch of the Chamber of Commerce. Its adjustment committee has similar duties to those of the Better Business Bureaus operated in larger cities. If a member of the Manufacturers Association hears a complaint about the product or business dealings of another member, it is his duty to report this to the adjustment committee, which makes an investigation, and irons out the difficulty.

The Longview brick and pipe plants are at Third and Florida avenues on a 4½-acre site. The pipe plant, 150 x 200 ft. makes all sizes from 4-in. to 54-in.

Water transportation is available by using the Cowlitz and Columbia rivers, and there are two spur lines, including 800 ft. of railroad trackage on the property. Warehouse facilities provide storage rooms for 3,000 cu. yds. of sand and gravel for use at the plants.

A Three-Shift Block Plant

With all due respect to the producers of machinery and the designers of factories, the most important part of a products plant is the man who runs it. If he is picayune, of narrow vision, the plant's output in quality and quantity reflects "the boss." All of which is by way of introduction to Lawrence Cox's plant at Hammond, Ind.—The Concrete Units Co.

The plant's equipment is for a production of 1500 to 1800 block with three men in a regular 9-hour day.

Yet the 1924 production was about 700,000 block. Divided into 300 working days which is a trifle too high considering Sundays, holidays and the unavoidable shut-downs which are the lot of even the best plants, that works out into a daily output of 2,333 block.

The plant shown in the sketch is not a model. It is just average and it doesn't stack up in size with most of the plants which have better than a half million annual output.

But Cox figured that to get the most out of the business the plant had to run, not intermittently with the biggest equipment, but constantly with less equipment—not only all the year round but with extra shifts. That's how it was done—three shifts the busiest time in summer and two the rest of the building year and one shift in winter.

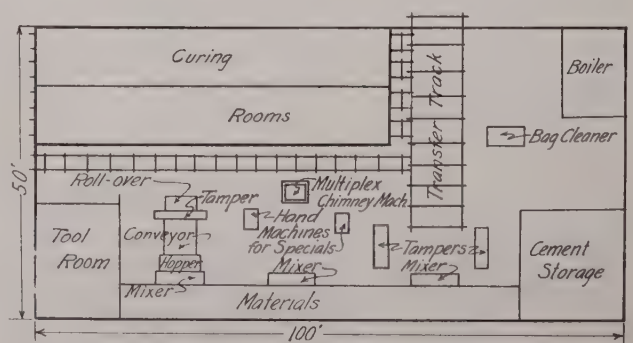
A shift is 9 hours so Cox puts the clock to shame and gets 27 hours into a day when the three shift period is on. Each shift of three men actually pounds out block for 7½ hrs. Then the machines are cleaned up, the block are unloaded and things generally set to rights while the next shift is getting into production. Thus the shifts overlap each other one hour.

The company was organized in August, 1918. In a little more than six years production has increased nearly 1000%; business is being obtained not only at home but at considerable distances; The Concrete Units Co. enjoys an enviable reputation not only for meritorious products but for service. The plant is busy all year round and a nice profit is rolled up right along.

The plant now has three Ideal machines with power tampers; one Ideal power roll-over stripper, three Multiplex chimney block machines; 3 Blystone mixers and an Ideal mixer, besides three Ideal hand machines for specials. The layout sketch doesn't show all this.

Virtually ever since the organization two shifts have been worked all year round, and in summer three shifts. To keep the plant busy Cox has supplied sales effort.

The normal production of the power face machines is 600 to 800 block per day with 3 men. On the hand roll-over the normal production is about 1200 block per day with 3 men. Machines are worked as follows: 3 men on the roll-over—one to mix, one to operate the machine and one to off-bear; 3 men working on the 2 down-face machines—one man operating each machine and one man mixing for the 2 machines. These 3 men on the 2 machines will average 1000 to 1100 block



Layout of the Concrete Units Company

per day. Altogether there are 3 men on the down face machines; 3 men on the roll-over; 1 man on the specials; 1 man out in the yard; Mr. Cox, who is superintendent, and his secretary in the office to take care of the phone calls and keep the books; and a salesman who is out on the job all the time.

With these productions is the fact that each shift must run its own block into the curing room and unload the block in the yard the next morning before starting to produce. Ordinarily production is figured on the actual time spent in producing, and special gangs to run block in the yard. This is all done in Cox's plant by each crew operating machines so most of the yard men are eliminated.

During the first year production ran to 70,000 block. For 1924 total sales were over 700,000.

Mr. Cox was formerly a banker and is well known through the Calumet district, embracing northwestern Indiana, the great Chicago district and much territory along Lake Michigan on the western boundary of Michigan. He has earned a reputation for delivering the goods. Cox's former connections were a great asset in obtaining business at a considerable distance from the plant—at times in volume too. For example this company was called upon to furnish block for Chicago's new Grant Park Stadium.

Of course the great percentage of orders is obtained in Hammond and nearby territory where the company is best known, and where block can more readily be sold on a competitive basis and deliveries made more easily. The management caters to both large and small contractors, working on the theory that "no order is too large to handle; none too small to claim our closest attention and best service." One contractor in Gary, Ind., used over 100,000 block in 1924.

In the fall of 1924 the average daily production was 2500 block; 150,000 in 1922. The goal for 1925 is 1,000,000 block.

There is an aim never to allow stocks to run low; much of the success of the Concrete Units Co., has been in operating under a twelve months plan.

The plant is on a siding of the Indiana Harbor Belt Line Railroad and the cars are unloaded from the switch directly into material storage bins. From these bins the material is shoveled by the mixer men into the mixers, of which there are three—one to feed the Ideal roll-over, one to take care of the two hand machines and chimney block machines, on which special blocks are made, and two mixers to take care of the three face-down outfits equipped with tamper. The blocks are taken directly from the machines onto the block cars. The two face down machines are served by a car standing directly on the transfer track. In the case of the roll-over the block cars must be pushed down a short stretch of track onto the transfer track. The curing rooms are so arranged that they are filled within the plant and unloaded onto the transfer track which serves the yard directly. The yard itself is served by two drive ways, so that the trucks can drive up directly to the block piles for easy loading.

It is a simple layout and without any expensive overhead structures.

Planning Conference

The National Conference of City Planning, New York City, announces that the first international town, city and regional planning congress to be held at the Pennsylvania Hotel and the Grand Central Palace, New York City, April 20 to 25, will bring together housing authorities from all parts of the world, and that it will be of special interest and value to this country as it will give opportunity to secure first hand information on the problem of better distribution of population and its effect on transportation and traffic. Probably the most comprehensive exhibit of city planning material ever assembled will be shown.

Concrete Fence Posts

Probably the most recent and comprehensive study of concrete fence posts has been issued by the Agricultural Experiment Station, Iowa State College, Ames, Ia., to meet a demand for definite knowledge of essentials in both materials and design to make serviceable, long-life posts. Methods of making are also presented and the whole subject discussed from the standpoint of economy and service.

The experiments on which the report is based were outlined in 1914. More than 700 posts were made; 48 were used in laboratory tests and the remainder in fencing the Agronomy farm of Iowa State College. The first report, written in 1916 by W. G. Kaiser, then assistant in agricultural engineering, was not published owing to the war and the bulletin finally issued in 1924 is from a revision of this first report with later information, prepared by J. B. Davidson.

The test posts were made in commercial molds[1] and in home made molds.

Mixtures and methods used are described as follows:

Proportion of Materials: Three different mixtures were used in making the experimental posts. The first 84 posts were made of a mixture of 1 part portland cement, 1½ parts fine sand and 3 parts coarse sand. The coarse sand passed through a ¼-in. mesh screen and was retained on ⅛-in. mesh screen. The next 50 posts were made from concrete of 1 part portland cement, 2½ parts bank run gravel which contained about 7% of clay. The remainder were made with 1 part portland cement to 2½ parts of washed gravel. It was the intent to make a good strong concrete with the materials at hand. The same strength could have been obtained with less cement, providing more coarse aggregate were used.

Mixing: The first few posts were made from concrete mixed on a mixing board with shovels, but for most of the posts a small power driven batch mixer was employed. A rather wet mix was used in order to obviate the necessity of much tamping but less water and more thorough tamping if practicable would have furnished stronger concrete.

Reinforcement: Three forms of reinforcement were used, viz: ¼-in. square twisted bars, No. 3 unannealed wire, and ⅝-in. by 18 gauge band steel. The influence of the reinforcement on the strength of the posts will be found in the table reporting the results of tests and the conclusions will be given later.

Spacers were used for the first 22 posts but were omitted from the remainder as the workmen objected to the time required for making and placing the spacers. The weakening of the posts by misplacement of the reinforcement, as revealed by the tests, indicates that spacers are a very important factor in securing proper location of the reinforcement.

Usually the mold was filled about one-third full of concrete which was worked down. The bottom reinforcement was then placed at the proper distance from the bottom and the mold filled with concrete.

NUMBER OF MOLD	CROSS SECTION TOP	CROSS SECTION BASE	LENGTH	WEIGHT - LBS.
1			7-6"	115-127
2			7'-0"	75-80
3			7-0"	83-90
4			7'0	59-65
5			7'-0"	112-120
6			7'0	95-103
7			7'0	112-120
8			7-0"	80-85

Fig. 1—Shapes, dimensions and weights of posts tested

[1]Acknowledgment is made to No. 1, D. & A. Post Mold Co., Three Rivers, Mich.; No. 2, Milwaukee Post Mold Co., Milwaukee, Wis.; No. 3, Ohio Post Mold Co., Toledo, Ohio; No. 4, Kimballton Construction Co., Atlantic, Iowa; No. 8, National Concrete Machinery Co., Madison, Wis.

The top reinforcement was then placed at the desired depth and the surface of the concrete smoothed with a trowel.

Cleaning the Molds: The molds were cleaned and oiled before each filling with concrete to insure that the post could be removed easily when the concrete had set. It was found that machine oil applied with a brush gave satisfactory results.

Records: A record of each individual post was made, including type, materials, mixture and reinforcement. A copper number plate was cast in each post for identification.

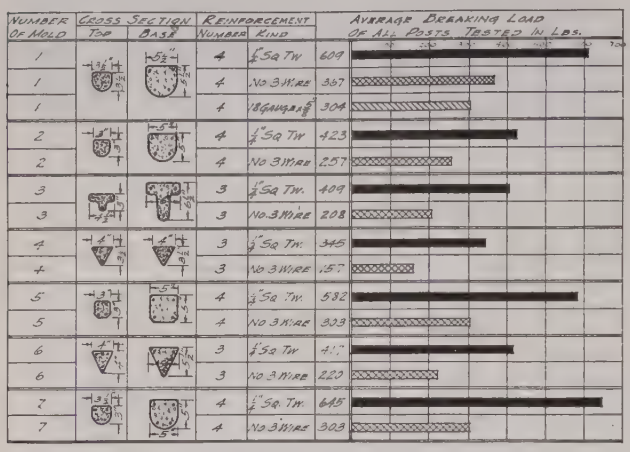

Number of Mold
Cross Section Top
Base
Reinforcement Number
Kind
Average Breaking Load of All Posts Tested in Lbs.
4 ¼" Sq Tw 609
4 No 3 Wire 367
4 18 Gauge Band 304
4 ¼" Sq Tw 423
4 No 3 Wire 257
3 ¼" Sq Tw. 409
3 No 3 Wire 208
3 ½" Sq Tw. 345
3 No 3 Wire 157
4 ½" Sq Tw. 532
4 No 3 Wire 303
3 ½" Sq Tw 417
3 No 3 Wire 220
4 ½" Sq Tw. 645
4 No 3 Wire 303

Fig. 2—Strength of seven types of posts as determined by test and the influence of the kind of reinforcement

For testing the posts a simple machine was built by which loads were applied similar to those to which posts are subjected in service.

The results of the tests are shown in Fig. 2, in which Nos. 1, 2, 3, 4 and 8 are posts made in commercial molds and 5, 6 and 7 in home made molds.

After nine years not one of the 650 posts set in the college fence has been replaced. The bulletin reports further:

It is a notable fact that not one of the 650 posts set in 1914 has been replaced at the end of 9 years. Few of the posts show any defects. Fifty-nine posts show longitudinal cracks, usually directly over the reinforcement rods because the latter were not placed far enough from the surface to secure adequate protection from corrosion. Only a few, however, are seriously injured. The worst example of this kind of defect is shown in Fig. 24. Fourteen of the posts have been chipped by contact with wagons or implements, but only in 3 posts is the injury serious. In general, most of the posts show little or no deterioration and it would be difficult to estimate their probable life. It is safe to suggest that many ought to be intact at the end of 50 years.

The bulletin gives the following general conclusions:

1. Very satisfactory fence posts may be made of concrete.

2. The life of a first class concrete post is very long; nine years indicates little deterioration.

3. A post with approximately square or round cross-section is the strongest for the material used.

4. A dense or rich concrete is needed to protect the steel reinforcement from corrosion.

5. The minimum amount of cement will be needed if sufficient coarse aggregate is used. For reinforcing the common sizes and types of posts in general use, four ¼-in. square twisted bars, or the equal, are needed for the utilization of the full strength of the concrete.

6. The steel reinforcement should be carefully placed, at least ¾ in. beneath the surface of the concrete, to secure maximum strength with adequate protection of the steel from corrosion.

7. Concrete posts make a fence of splendid appearance.

8. The cost of maintaining a concrete post is very small.

9. The opportunity for failure is large with poor workmanship or low quality materials.

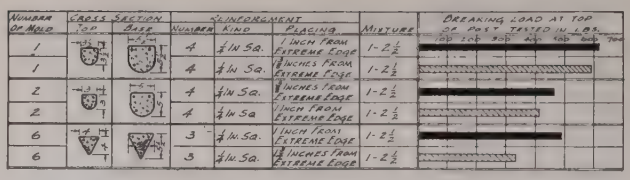

Number of Mold
Cross Section Top
Base
Reinforcement Number
Kind
Placing
Mixture
Breaking Load at Top of Post Tested in Lbs.
1 ¼ In Sq. 1 Inch from Extreme Edge 1-2½
1 ¼ In Sq. 2 Inches from Extreme Edge 1-2½
2 ¼ In Sq. 2 Inches from Extreme Edge 1-2½
2 ¼ In Sq 1 Inch from Extreme Edge 1-2½
6 ¼ In. Sq. 1 Inch from Extreme Edge 1-2½
6 ¼ In. Sq. 2 Inches from Extreme Edge 1-2½

Fig. 3—Influence of location of reinforcement upon strength

These additional suggestions are added:

Molds or Forms: Steel molds offer advantages in that they give a better surface finish to the post and also better withstand the effects of use than wooden forms. Forms Nos. 6 and 7 were home-made molds of sheet metal and were used successfully. Commercial molds have added advantages in convenience for handling which are not easily secured in forms made by the user. Shaking and jostling devices contribute especially to the ease of making and the general improvement of the posts. Where a few posts, however, are to be made, molds made of wood are the most convenient to make.

Size of Post: There seems to be no definite way to determine just how large or how strong a concrete post should be. Although the posts tested in service varied in weight from 60 to 127 lbs. and had an average breaking strength from 157 to 609 lbs. applied at the top to the posts when set, all these posts have held the fences in place. The service has not been particularly severe such as would be the case of lot fences. It would appear, however, that a 7-ft. post having a strength of 500 lbs. would be above the average requirement. A post of the dimensions of No. 5, or those made in the form shown in Fig. 25, when of good concrete properly reinforced will easily have this strength.

Reinforcement: This investigation revealed that concrete posts were in general inadequately reinforced to secure the maximum strength of the concrete. Four ¼-in. bars of reinforceing steel of high tensile strength is not too much for a post of the size ond strength suggested. Soft or annealed steel should be avoided, and twisted or special form steel is clearly more desirable than smooth round steel rods.

Curing: The concrete post, on account of its slender form and large amount of surface, should be carefully cured. The posts should be handled carefully until fully hardened and during the curing process should be kept moist by sprinkling for ten days after making. Posts ordinarily should not be set until they have cured for at least three months.

Fastening the Wire: Various schemes have been suggested as a means of attaching the fence wire to the posts. The loop tie has been proved to be satisfactory.

A Study of the Results

No. 3 wire failed by the stretching or breaking of the reinforcement.

An examination of the broken posts showed that with the No. 3 wire the bond between the steel and concrete was broken on either side of the fracture. With the ¼-in. square bar the bond between the steel and concrete was not broken.

The No. 3 wire was purchased in straightened cut lengths. The straightening process twisted the wire and had an injurious effect upon its strength.

In posts reinforced with ½-in. square bars failure was due to the crushing of the concrete. In all cases the posts reinforced with No. 3 wire failed by the breaking or the stretching of the steel.

The reinforcement of band steel (No. 18 gauge by ⅝ in.) did not show the strength of the No. 3. The advantage claimed for band steel is that it provides extra surface for bonding with the concrete.

The placing of the reinforcement is an important matter. If not placed near the surface the strength of the post will be reduced, while if not sufficiently covered with concrete the steel will not be protected from corrosion. Although an attempt was made to place the steel carefully in the posts, the test revealed that the steel was sometimes misplaced.

Although a good dense concrete was used for all the posts, it is significant that a 1:1½:3 mixture of graded material gave greater strength than a 1:2½ mixture of ungraded material. It is to be emphasized that much cement may be saved by using the proper proportion of coarse material.

An inspection of a large number of concrete posts has been made in several parts of the State. Although some splendid posts have been found, enough failures were observed to justify a special effort to caution prospective makers of posts that the essentials of construction previously mentioned must be provided. In a few instances the users strongly condemned concrete fence posts. Failures were due to a number of causes, but chiefly corrosion of steel due to inadequate protection, wrong kind and insufficient reinforcement, insufficient cement in mixture, improper curing and careless workmanship. It is very evident that the making of satisfactory concrete posts requires much care and skill.

Graded Aggregate

An Economic Basis for Sizes

A system by which the sizes of such necessities of life as frying pans, loaves of bread, desk tops, trunks, and insurance policy premiums, may some day be established according to a sound scientific principle, is under consideration by a committee recently appointed by the American Engineering Standards Committee to study the possibilities of systems of size-series which are enlisting the interest of many engineers of the industrial countries of Europe, particularly in the mechanical and electrical engineering fields.

These series, which are called "preferred numbers," seek to provide a consistent, systematic basis for sizes, capacities, and ratings, by setting up a series in which each number is a definite and uniform percentage larger than the one preceding it. Thus, 10, 16, 25, 40, 64, 100, 160, 250, 400, etc., where each size is about 60% larger than the preceding, is a series of such preferred numbers. These same numbers might be used for the widest variety of articles.

The subject is presented and discussed in detail in various papers and reprints which can be obtained from the A. E. S. C. Some of these treat the subject from the popular point of view, and others from the more scientific viewpoint of the standardization expert.

The A. E. S. C. Committee includes formally designated representatives of technical societies, government departments and trade associations.

* * *

Some Characteristics of Portland Cement

Among common questions which are asked regarding portland cement and concrete, the following are of interest:

What is the usual percentage of free lime in portland cement?

Since such cement is made by the chemical union of aluminates and silicates with lime, is it not possible to have enough of the former present to completely use up the lime?

What would be the approximate chemical analysis of a perfect portland cement?

In reply to these questions, authorities on the subject seem to be agreed upon the point that properly made portland cement contains no free lime. However, on the addition of water to the cement, lime is immediately set free, and this process of breaking down of silicates with the separation of lime constitutes the process of setting. The soundness test specified for portland cement when satisfactorily met indicates that the amount of uncombined lime is negligible or zero.

There can be no such product as a perfect portland cement. The best of this material is a heterogeneous mixture of two silicates, one aluminate and various iron compounds of lime. When these are combined, so that there is no uncombined silica, lime, alumina, etc., the cement is considered properly made. It may not, however, be very satisfactory so far as hardening, etc. is concerned. It is for this reason that our standard specifications give a minimum requirement for strength.

The subject of crazing is one that is receiving wide attention by users of concrete, particularly where surface finishes are attempted, the surface being distinctly different from the rest of the concrete.

In any product such as is obtained with a 1:1 mix using a 12 to 16 mesh aggregate with a 3% admixture of lime and cast on a steel plate to give a glass like surface, crazing may be expected. This is due to the fact that the surface and the rest of the product have distinct properties such as coefficient of expansion, modulus of elasticity, etc. As a consequence, producers of this type of material are developing surfaces and textures of the concrete of the type that is not smooth and in which the surface is the same as the rest of the body. Practically all white coats on the interior walls of houses are badly crazed. This can be shown by simply wetting them which will cause the cracks to show very prominently.

* * *

Monthly Reports on Block Quality

The C. E. Lindsley Co., Inc., Irvington, N. J., manufacturers of Zagelmeyer wet cast concrete block, has been doing some highly constructive direct mail advertising of a kind that is bound to be convincing with any fairly intelligent buyer prospect.

A letter size folder done on attractive cover paper and having a small photographic print of a Lindsley block, contained a double page separate sheet reporting tests by Columbia University. The tests reported in the January folder were made in December. In February a new sheet was mailed reporting tests made in January; a March mailing reported tests in February.

These monthly reports are punched to be bound with the cover sent out with the first report in January.

The December 9 tests of block made November 10 showed compressive strength gross area (average of 5 block) of 1097 lbs., varying from 1055 to 1165 lbs. and 8.8% absorption on 48 hour immersion.

The January 16 tests of block made Dec. 11, showed an average strength (of 5 samples) of 1199 lbs. varying from 1040 to 1270 lbs. and an absorption of 7.1%.

The February 10 tests of block made January 13 showed 1417 lbs. as an average of 5 ranging from 1205 to 1570 lbs. and an absorption of 4.4%.

Each report also shows the requirements of the New York City building code of 750 lbs. strength and 12% absorption average or 15% maximum.

The first of the series carries the line, "46% above building code requirements;" the second "60% above;" the third, "88% above."

* * *

Slag and Coke Breeze for Block Aggregate

William Person, Person Slagtex Co., Ashland, Ky., is using both slag and coke breeze as an aggregate in making concrete block and brick. He writes to CONCRETE:

"The slag used is ordinarily known as No. 7 slag, though I find that the regular run of No. 7 does not contain enough fines, so the slag company here has put in a special screen to furnish the desired grade. All of my aggregate passes through a ½-in. screen and usually about 80% of this will pass through a No. 10 screen; this, however, is variable, depending upon the quality of the slag, a slag with a high lime content will have a larger proportion of fines and a lean slag a smaller percentage, but this variation is not great enough to affect my operation.

"My mix is one part of cement and six parts of slag. This produces a block that is hard, tough and light gray in color and I find superior in every way to the sand and gravel block. An 8 x 8 x 16 Slagtex block weighs 50 lbs.—this with 33% air space.

"The aggregate which I believe has a greater future than either slag or cinders is coke breeze. I have been trying this out in a small way. It looks mighty good. I am making

the 8-in. block for outside walls and the 6-in. block for interior walls. The 6-in. block also have 33% air space. Stucco is applied directly to the outside of the block and plaster to the inside walls.

"These block have a compression strength of 800 lb. and better, an absorption of 7% and less, weigh just half as much as the Slagtex block, and are very tough although nails can be driven in them. I believe they make the strongest and lightest building material obtainable, and have an unexcelled surface for stucco and plaster."

* * *

Nail-Holding Power of Cinder Concrete

Some time ago the Pittsburgh Testing Laboratory, Pittsburgh, Pa., made tests for F. J. Straub, New Kensington, Pa. to determine the holding power of wire nails in cinder building blocks as compared with wood. Samples were placed in a Universal testing machine and the loads required to draw the nails determined. The results were:

RESULTS OF TESTS

Size of Nail	Material Used	Depth of Nail in Material	Load in Pounds Required to Draw Nails
20 d	2x4 Yellow Pine	1½	260
16 d	do	2	330
16 d	do	1½	270
16 d	1 in. Ash Board	⅞	470
20 d	Cinder Concrete Block	1½	300
20 d	do	1½	250
20 d	do	1½	200
16 d	do	1½	200
16 d	do	⅞	50
*20 d Old Nail	Cinder Concrete Block —5 years old	1½	650

*This specimen was a nail which had been driven into a cinder block used in the walls of a bottling plant in New Kensington, Pa. When the building was partly destroyed by fire, this specimen was selected to determine the effect of age on the holding power of the nail. The nail had not rusted in the concrette, although it had rusted where not embedded.

* * *

Scientific Design of Mixtures

It is interesting how the leaven of promotional effort for better concrete actually works. One way is seen in the announcement of Elwyn E. Seelye, consulting engineer on reinforced concrete, of the establishment of a department in charge of George Conahey, tutored in the scientific design of concrete mixes under Prof. D. A. Abrams, at Lewis Institute, and with the Portland Cement Association, to handle this work in the field under Lewis Institute methods.

* * *

Products Program for 1925

Below are listed the various activities which the Wisconsin Concrete Products Association will stress during 1925.

1. Production of Quality Products—To improve and maintain the quality of concrete products by a practical application of laboratory methods to plant operation. Not only is it intended to increase quality, but in so doing, reduce production cost.

2. Merchandising and Advertising—To assist in every way practical a greater distribution of our products by the application of modern methods of merchandising and advertising.

3. Law Enforcement—To work with proper officials, both state and local to see that proper legislation is enacted and enforced, making possible the use of only quality products in masonry construction.

4. Education—To educate not only the building public, but our own members and employees, in the use of our product and in the various steps we have taken to control it's quality.

5. Freight Rates—To secure just and equitable freight rates that will allow fair competition with competitive materials and allow a greater expansion of our present markets.

6. Publicity—To secure, wherever possible, proper publicity on the work of our Association and it's members through national and local publications.

7. Home Construction—To, wherever possible, put our product in buildings "above the grade," particularly in the line of home construction.

8. Large Building Construction—To work with architects, contractors and builders to include concrete products in specifications for factories, warehouses and public buildings.

9. Insurance Rates—To work with Fire Insurance Companies and Actuarial Bureaus, both through local and state agents to secure insurance rates on concrete masonry buildings in accord with the rating accorded this type of construction by the Underwriters' Laboratories.

10. Affiliation with National—To affiliate with the Concrete Products Association (National) and participate in the work and benefits of that organization.

* * *

Design and Control of Concrete Mixtures

To aid the people in the construction industry, who everyday are putting into practice the established principles recognized as essential for the production of good concrete, the Portland Cement Association has issued a publication entitled *Design and Control of Concrete Mixtures*. This booklet describes the simple equipment required and the tests to be made on the job in order to secure concrete of pre-determined strength. Typical examples show how easy the principles are to apply. The subject matter deals with the factors that control the potential strength of concrete.

It is pointed out in the introduction that the assumption is made that the reader is familiar with the essential requirements for quality concrete and appreciates the necessity of complete mixing, careful placing and proper curing or protection after placing. Accepted standard methods for determining the suitability of aggregates have also been included as they constitute an important operation in controlling the quality of concrete.

The water ratio theory is explained and the design of concrete mixtures is stated to involve consideration of the effect of the following three factors on the water ratio:

1. Size and grading of fine and coarse aggregates.
2. Consistency or workability of concrete.
3. Quality of cement.

The practical operations involved in design and control of concrete mixtures with field equipment are described and illustrated. A list of published articles on field tests of concrete is included.

* * *

Mathias Koenen

By E. Lee Heidenreich

Dr. Ing. Mathias Koenen, who died recently, was born in Cologne in 1846, and reached the age of 79 years. When Monier in 1878 patented his invention as reinforced concrete, he had no idea of its great possibilities, which first were realized by Dr. Koenen, who laid the first theoretical considerations before the public.

Dr. Koenen first recognized the peculiar bonding strength between concrete and steel, in such manner, that while the concrete was eminently adapted to withstand compression, steel was equally well constituted to take care of tension, and by means of this combination scientifically arranged, a new and wonderful building material was produced, which soon made itself felt throughout the building methods over the entire surface of the globe.

In 1887 appeared a pamphlet *Das System Monier in seiner Anwendung auf das gesammte Bauwesen* by G. A. Wayss, who had bought the Monier patent, and this pamphlet was written principally by Dr. Koenen, and for the first time gave to the world the true inside of the theory of reinforced concrete, forming the basis for its remarkable progress from that time on.

While Monier was more or less an accidental inventor, Dr. Koenen recognized the real value of the combination and

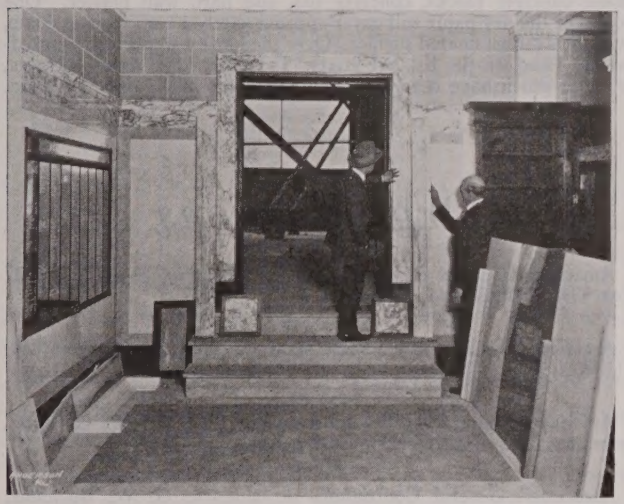
created its proper theory, which enabled other engineers to make the history of reinforced concrete so epoch-making.

For years Dr. Koenen fought not only other engineers, but also the rules and regulations of departments of public works, who were looking askance at any novel construction, that would revolutionize the then traditional building methods, but in the end, the courage of his own conviction convinced both his colleagues and the official authorities, and reinforced concrete prevailed.

When the writer read his first paper on "Monier Constructions" in 1893, he used the information found in Koenen's works.

* * *

Burkemarble a Cement-Silica Product

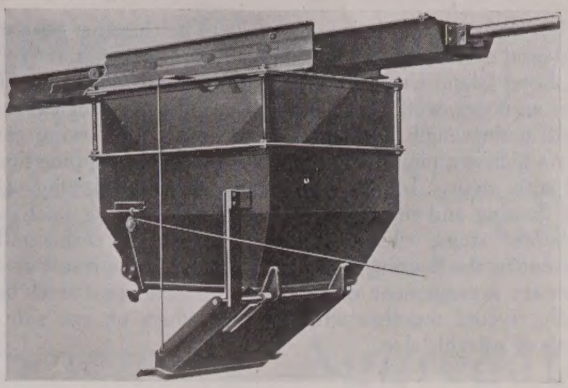


Dwelling in marble halls has always seemed such a desirable thing to so many people that to produce a semblance of marble at a low cost has been the aim of many an experimentor and inventor. The illustration shows an exhibit of Burkemarble, the invention of J. J. Burke, an architect and builder, formerly of Tulsa, Okla. and now in Kansas City where a company has been organized for its manufacture. It is said to be a cement-silica combination under the influence of certain chemicals, produced at a very low cost. Color, veining and texture are said to be very like natural marble and the process is said to eliminate expense of surface veining and other finishing treatments, the material being homogeneous throughout and completed in a single operation, the finish being automatically achieved in the curing. The material is reported as of high tensile strength, can be reinforced as with ordinary concrete and is non-absorbent to a high degree. The plant of the Marble Products Co., Kansas City, Mo., where it has been produced on a small scale, is being enlarged for its more extensive production. CONCRETE is indebted to E. Lee Heidenreich, for the information.

Adjustable Measuring Batcher

The Blaw-Knox adjustable measuring batcher, shown in the accompanying illustration, which is designed for the automatic and accurate measuring of concrete aggregates has many new features in the 1925 design which, according to the Blaw-Knox Co., Pittsburgh, Pa., the manufacturers, have increased its utility, prolonged its life and increased its labor-saving features.

The construction of the sand and stone batchers is identical, giving the contractor a greater latitude in the use of his equipment. As the lower section of the batcher is built truly square, it can be turned and replaced on the upper cone so



Blaw-Knox adjustable batcher

that the discharge gate opens in any direction. This enables the contractor to suit the delivery of the measured batches to varying requirements of different systems of operation. A glance at a semaphore indicator tells the operator whether the batcher is full or empty. Clean discharge is assured, due to the shape of the batcher, having a slope of 60° or better. More rapid discharge of the batcher is provided for in the new design.

New Power Unit for Contractors

The Denison Powermaker is a new type of internal combustion engine designed especially for contractors' equipment. Engineering features that have proved so successful in the European countries have been used. It is an inverted, two cylinder, four cycle, water cooled engine entirely housed in a sixteen gauge pressed steel casing. The cylinders, bearing standards and base are all included in one casting, which makes the unit very rigid, with permanent and proper alignment of piston, crank shaft and cam shaft. This also lowers the center of gravity over the entire unit. The crank shaft, cam shaft, magneto, governor assembly and also the connecting rods being located on top of the main base casting are very accessible, so that adjustments can be quickly and easily made. The valve box which includes the valves, intake and exhaust manifold and carburetor can be quickly and easily removed by taking out six machine bolts. It is a simply and compactly built engine. Cooling water from the radiator upon entering the cylinder block, strikes the cylinder head, which is the hottest part of the unit, and rises as it is heated, producing rapid water circulation and uniform cooling. Air is drawn through the radiator, which is mounted at the rear of the main casting by a fly wheel Sirocco type fan. The radiator is shrouded, so that the dust and dirt going through it with the air do not come in contact with any part of the working mechanism. The fuel tank is located at the top of the housing. Power can be taken from the crank shaft at speeds ranging from 500 to 1200 r. p. m. and from the gear reduction shaft at speeds ranging from 250 to 600 r. p. m., giving a power range of from 5 to 12 h. p. from either shaft. The base dimensions of the Denison Powermaker are 28¾ x23¾ and the height is 33 in. It weighs 550 pounds.

Thick Double Wall Construction

The photographs used to illustrate the article "Thick Double Wall Concrete Construction in California" on page 78 of CONCRETE for March, should have been credited to Mott Studios, Los Angeles, to which we are glad to make tardy acknowledgment.

Steel Flooring and Stair Steps

That insurance statistics show falls to be the chief source of accidental casualties, is pointed out by the Irving Iron Works Co., Long Island City, N. Y., and that about half of the falls occur on floors, walk-ways and stairs. The most logical safeguard against such accidents, according to the Irving company which is a pioneer, is the adoption of non-slipping floors and stair steps. In the Irving Sub-way, non-slipping open steel flooring and the Irving Safestep, non-slipping steel stair or ladder steps, the non-slipping feature is permanently inherent in the flooring and step itself and is the result of the alternate arrangement of straight and reticuline steel bars solidly riveted together with all edges flush on one side in panels of suitable size.

Trade Publications

Concrete floors when once laid ought not to be cut into; but sometimes, wear or the removal or installation of machinery makes a patch essential. How silicate of soda can be used to insure a good bond between old and new concrete is pointed out by the Philadelphia Quartz Co., in *P's and Q's*. First the hole should be chipped out clean and of such a shape that the new piece will lock into the old concrete, that is, the hole should be somewhat undercut. The fresh surface should then be painted with "N" silicate. Pure portland cement may then be dusted over the surface and worked in with a broom or stiff brush. The fresh concrete can then be applied in the usual manner. The same publication discusses resurfacing.

The *United States Standard block machines, concrete mixers, power tampers* provide the subject matter of a well printed and attractive publication issued by the United States Standard Manufacturing Co., Columbiana, Ohio. It is of a 6x9-in. size, with 48 pages; gives a pretty thorough treatment in both illustrations and text of the standard line of concrete block machines, power tampers, concrete mixers, curing cars, adjustable sill cap and step molds and chimney block molds.

Barrett portable elevators provide the subject matter for bulletin No. 300 issued by the Barrett-Cravens Co., 1328 West Monroe St., Chicago. The publication, which is of 18 pages, describes and illustrates the use of these portable elevators in storing and handling materials in all sorts of packages and under many different conditions.

Van Guilder System is the title of a new publication issued by Van Guilder System Concrete Buildings, Inc., 15 East 40th St., New York City. Readers of CONCRETE are familiar with the Van Guilder machines and the work which they do in double wall construction through articles which have been published descriptive of jobs of this kind for a number of years past. It is interesting in new trade publications to learn how George Burford Hopper, the president of the new controlling company, came to take over the production and distribution of these machines, through using them for a number of years in the work of Isaac A. Hopper's Sons in all sorts of building construction. It is understood that the machines are now for sale outright without royalty or territorial rights restrictions.

Barrett Lift Trucks in Concrete Products Plants is the title of a special bulletin issued by the Barrett-Cravens Co., 1328 West Monroe St., Chicago. It describes and illustrates the use of these lift trucks which already have an extensive application in the products business in handling green and cured products on racks to and from curing rooms.

The *Heil street sprinkler tank* and special body for municipal use in the collection of garbage and other refuse form the subject matter of bulletin No. 146, issued by the Heil Co., Milwaukee, Wisc. The bulletin is profusely illustrated and describes and gives specifications in brief for equipment in the lines mentioned. Another bulletin of the Heil Co., is under the title *For Best Results Use Heil Dump Bodies and Hoists*. This covers the use of the equipment for many different purposes and is profusely illustrated.

The Warren-Knight Co., Philadelphia, Pa., has just issued a folder CC-27 describing the company's line of transits designed to insure accuracy and prevent costly replacements for the contractor on the construction job. These transits are described as most convenient to use and capable of withstanding an amazing amount of rough handling.

Universal Vibrating Screens, catalog No. 50, has been issued by the Universal Vibrating Screen Co., Racine, Wis., describing what is claimed to be the mechanical vibrator with the highest efficiency.

This catalog is 6 in. x 9 in. and has 24 pages with paper covers. It is clearly illustrated, giving details of the parts which it is claimed insure unsurpassed efficiency and also illustrations of actual screen installations in the crushed stone and gravel producing industry.

Niagara Electric Steam Radiators are illustrated and described in the circular issued by the Buffalo Gas Radiator Corp., Tonawanda, N. Y. Units of various sizes that can be plugged into an electric outlet anywhere for localized heating purposes, are offered.

Medusa Cement Paint is the subject matter of circulars issued by the Sandusky Cement Co., Cleveland, Ohio. It has been on the market now a little over three years. It is a combination of Medusa white portland cement and chemicals, and comes in several colors, furnished in dry powder form, in 10-lb. cans and 350-lb. iron drums. It is mixed with a certain definite amount of water, and the makers say that when applied to a masonry surface, it will not dust, or chalk, peel or blister, burn or permit the passage of rain or dampness, and that the colors are permanent and will not fade. Any dirt or dust which may settle on the paint film may be washed off by the use of strong soap powder and brushes, without harm to the paint.

Originally formulated for the express purpose of application to the interior face of basement walls for dampproofing only, the field of use for Medusa cement paint has broadened considerably. It has been used for rainproofing and decorating stucco, concrete, brick, stone, concrete blocks, concrete tile, and hard wall plaster. One pound of the dry paint will cover approximately 12 sq. ft., two coats, over the average floated surface. Over the hard wall plaster, approximately 14 sq. ft. per lb., two coats. It is applied to damp surfaces, or those which have been sprinkled just before the paint is applied.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Committee; Dr. P. G. Agne, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High Street, Columbus, Ohio.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., New York City.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.